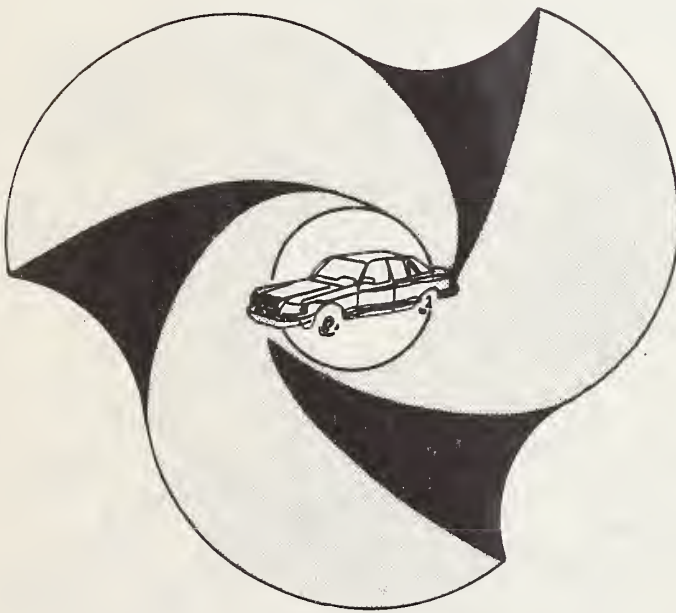


S Morrison-Maierle
625.7042 High hazard
M26gchh location study for
1987 Gallatin County,
Montana

TRAFFIC SAFETY IMPROVEMENT STUDY

FOR GALLATIN COUNTY ROAD OFFICE

BOZEMAN , MONTANA



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HIGH HAZARD LOCATION STUDY
FOR
GALLATIN COUNTY, MONTANA

Department of Justice, Contract #87-06-04-1

October 1987

Prepared by:

MORRISON-MAIERLE, INC.
BOZEMAN, MONTANA

M-M Project Number 928-21-01(46)

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1. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The following 10 sites were selected for analysis in this High Hazard Location Study by Gallatin County and the Highway Traffic Safety Division of the Department of Justice based on accident history and roadway characteristics. The specific site locations have been further refined based on analyses of available accident reports. Site 2 was divided to create 2 sites--Site 2W and 2E.

SITE 1, Cottonwood Creek Road

SITE 2W, West Intersection of South 3rd Avenue & Goldenstein Road

SITE 2E, East Intersection of South 3rd Avenue & Goldenstein Road

SITE 3, Intersection of Gooch Hill Road & US 191

SITE 4, Intersection of Bozeman Trail Road & I-90 East Frontage Road

SITE 5, Intersection of Ferguson Road and Durston Road

SITE 6, Intersection of Valley Center Road & BN Railroad

SITE 7, Sypes Canyon Road in Section 18, T1S, R6E

SITE 8, Jackson Creek Road in Section 34, T1S, R7E

SITE 9, Intersection of Baxter Road & Flanders Mill Road

SITE 10, Intersection of Bozeman Trail, Sunset Blvd. & Haggerty Lane

The locations of the sites are shown on Figure 1.

The sites were each evaluated based on procedures outlined in Report No. FHWA-RD-77-83, "Identification of Hazardous Locations" as revised and supplemented by the Montana Department of Highways Report "Safety Engineering Improvement Program" and the report DCA Project No. 79-04-01-01, "Preliminary Evaluation Program for High Hazard Location Study, Yellowstone County, Montana".

The following tables are included to help describe and compare the hazardousness or priority of the sites:

Table 1. lists the sites in the order of their hazard indices.

Table 2. lists the sites in the order of their benefit/cost indices.

Table 3. lists the sites in the order of their priority indices.

Table 4 lists the sites based on the three accident based indicators. The three accident indicators are number of accidents, accident rate and accident severity.

Table 5. lists the sites based on the total of the four non-accident indicators. The four non-accident indicators are volume/capacity ratio, sight distance, driver expectancy and information systems deficiencies.

Table 6. compares the rankings established by Tables 1. through 5.

It is recommended that the short term improvements recommended in this report be completed in the order listed in Table 3, Priority Indices.

TABLE 1
RANKING BY HAZARD INDEX

RANK	SITE	HAZARD INDEX
----	----	-----
1	8	67
2	1	53
3	6	53
4	5	47
5	7	44
6	2W	43
7	9	43
8	2E	38
9	4	38
10	10	33
11	3	30

TABLE 2
RANKING BY BENEFIT/COST INDEX

RANK	SITE	BENEFIT COST INDEX
----	----	-----
1	4	92
2	10	92
3	2E	88
4	6	84
5	5	76
6	7	65
7	8	48
8	9	44
9	2W	35
10	1	23
11	3	0

TABLE 3
RANKING BY PRIORITY INDEX

RANK	SITE	PRIORITY INDEX
-----	-----	-----
1	8	62
2	6	61
3	5	54
4	4	52
5	2E	51
6	7	49
7	10	48
8	1	46
9	9	43
10	2W	41
11	3	23

TABLE 4
RANKING BY ACCIDENT INDICATORS

RANK	SITE	ACCIDENT INDICATORS
-----	-----	-----
1	8	40
2	1	33
3	5	30
4	2W	27
5	7	25
6	9	24
7	4	23
8	6	22
9	2E	22
10	10	19
11	3	18

TABLE 5
RANKING BY NON-ACCIDENT INDICATORS

RANK	SITE	NON- ACCIDENT INDICATORS
----	----	-----
1	6	30
2	8	27
3	1	20
4	7	19
5	9	18
6	5	17
7	2W	16
8	2E	16
9	4	16
10	10	13
11	3	13

TABLE 6
COMPARISON OF RANKINGS

SITE	HAZARD INDEX	BENEFIT COST INDEX	PRIORITY INDEX	ACCIDENT INDICATORS	NON- ACCIDENT INDICATORS
----	-----	-----	-----	-----	-----
1	53	23	46	33	20
2W	43	35	41	27	16
2E	38	88	51	22	16
3	30	0	23	18	13
4	38	92	52	23	16
5	47	76	54	30	17
6	53	84	61	22	30
7	44	65	49	25	19
8	67	48	62	40	27
9	43	44	43	24	18
10	33	92	48	19	13

2. STUDY METHODOLOGY

2.1. INTRODUCTION

Ten sites were selected for this study by Gallatin County and the Highway Traffic Safety Division of the Montana Department of Justice. Site 2 was divided into two sites, Site 2W and Site 2E, to address two different conditions. A total of 11 sites are therefore included in this report. This study includes the following phases for the evaluation of the sites:

1. Collection and Evaluation of Accident Data.
2. Field Inspection and Survey.
3. Analysis of Data and Calculation of Hazard Indices.
4. Preliminary Design and Calculation of Benefit/Cost Ratio.
5. Establishment of Priority Index.

The follow sections explain and discuss each of the five phases.

2.2. COLLECTION AND EVALUATION OF ACCIDENT DATA

This phase involves obtaining copies of all accident data available in the microfilm files of the Montana Department of Justice for the accident period selected for the study (1980 TO 1986). The data were then analyzed by plotting each accident on a "Collision Diagram" and summarizing the data on an "Accident Data" Form. (The "Collision Diagram" and the "Accident Data" form are included with the section of this report discussing each site.) The accident data was then available to the engineers and county personnel as each site was field inspected and surveyed.

2.3. FIELD INSPECTION AND SURVEY

Using information provided by the county on the location of each site and the above mentioned accident data, each site was reviewed and studied in the field. This field survey and inspection included:

1. Measurement and survey to determine existing geometrics at the site. Information obtained included width of pavement, degree of horizontal curvature, vertical grades and super elevation.
2. Measurement of sight distances from approaching vehicles to the hazard (curve or intersection).
3. Traffic counts. In most cases counts were made using an automatic traffic counter over a period of 24 hours.
4. A partial sign inventory including measurement of location, size and height and a review at night to determine reflectivity.

5. Other miscellaneous data were obtained including posted speed limit, distance to and type of obstructions, character of adjacent and connecting roads, type and character of traffic and other items that might affect safety at the sites.
6. The "Information Systems Deficiencies Rating Form" and the "Driver Expectancy Problems Rating Form" were completed in the field for each site.

2.4. ANALYSIS OF DATA AND CALCULATION OF HAZARD INDICES

Each of the 11 sites selected was evaluated for hazardness and was assigned an indicator value (I.V.) for each of the following seven measures or indicators:

1. Number of Accidents
2. Accident Rate
3. Accident Severity
4. Volume/Capacity Ratio
5. Sight Distance
6. Driver Expectancy
7. Information System Deficiencies

After the seven indicator values for each site were established, partial hazard indices were assigned based on the following relationships:

Partial H.I.	=	0.164 times (I.V.) for Number of Accidents
		0.225 times (I.V.) for Accident Rate
		0.191 times (I.V.) for Accident Severity
		0.082 times (I.V.) for Volume/Capacity Ratio
		0.074 times (I.V.) for Sight Distance
		0.149 times (I.V.) for Driver Expectancy
		0.115 times (I.V.) for Information System
		Deficiencies

		1.000 Total Hazard Index

The total hazard index for each site is the sum of the seven partial H.I.'s calculated.

2.5. DISCUSSION OF HAZARD INDEX (H.I.)

Each of the indicators used in the hazard index equation is a measure of some aspect of the hazardousness of a particular location. Some indicators are stronger than others, of course, and the individual indicator values are therefore weighted according to their ability to predict future accident experience. Larger values indicate higher degrees of hazardousness.

Two indicators discussed in the FHWA report (Report FHWA-RD-77-83, Identification of Hazardous Locations) have not been included. These are traffic conflicts and erratic maneuvers. These indicators are not recommended for use because most of the

roads maintained by the County are relatively low volume roads. The sampling for either of these parameters would require observation for periods of from several hours to days in order to get a statistically valid sample. It is not felt that the benefit gained would justify the cost or the time involved with either of these parameters.

The weighting factors used in the hazard index formula recommended are basically identical to those suggested in the FHWA report. The weighting factors have been adjusted however to account for the exclusion of the traffic conflicts and erratic maneuvers indicators. Indicator values range from 0 to 100. Charts for converting raw data to indicator values for each of the seven indicators to be used are included on following pages.

Following is a brief explanation of each of the indicators recommended for inclusion in the hazard index formula and a discussion of the modifications to the indicator values presented in the FHWA and DCA reports.

2.5.1. Indicator 1: Number of Accidents

The data used to arrive at an Indicator Value for accidents is the average number of accidents per year using data from the study period. The 7 year period from 1980 to 1986 is used for this and the other two accident related indicators.

Figure 2, at the end of this chapter, shows the relationship between average number of accidents per year and indicator values.

2.5.2. Indicator 2: Accident Rate

The data used to arrive at an indicator value is the number of accidents per million vehicles entering a location. Again a seven year period was used to account for the random occurrence of accidents. The accident rate was then determined by dividing the number of accidents by the sum of the approach volumes.

Figure 3, at the end of this chapter, shows the relationship between ACC/MEV and indicator value.

2.5.3. Indicator 3: Accident Severity

This indicator provides a means of identifying the hazardousness of a location based on the severity of accidents at that location. If two locations have approximately equal accident rates a difference in severity will be a strong indicator of which location is the more hazardous.

The data input for this indicator is the "Average Relative Severity Index" (RSI). Again accidents over a seven year period were used to determine the RSI. The FHWA report recommends using RSI values as shown in Table 7. It should be noted that the RSI

TABLE 7, RELATIVE SEVERITY INDEX

<u>Type of Accident</u>	<u>RSI</u>	
	<u>Urban</u>	<u>Rural</u>
<u>Multi-Vehicle, At Intersection</u>		
Entering at angle	\$ 4,300	\$ 14,400
From same direction -- both going straight	2,800	5,100
From same direction -- one turn, one straight	2,500	5,100
From same direction -- one stopped	3,800	5,200
From same direction -- all others	2,000	6,300
From opposite direction -- both going straight	4,000	20,000
From opposite direction -- one left turn, one straight	4,400	15,400
From opposite direction -- all others	2,700	3,800
Not stated	3,800	5,200
<u>Multi-Vehicle, Non-Intersection</u>		
Going opposite direction -- both moving	\$ 4,400	\$ 19,600
Going same direction -- both moving	2,900	8,100
One car parked	1,600	2,400
One car stopped in traffic	4,200	6,800
One car entering parked position	1,900	2,300
One car leaving parked position	1,200	2,700
One car entering alley or driveway	3,400	6,000
One car leaving alley or driveway	2,000	4,400
All others	1,700	7,600
Not stated	3,400	6,000
<u>Motor Vehicle with Pedestrian, At Intersection and Non-Intersection</u>		
Vehicle going straight	\$ 20,000	\$ 49,000
Vehicle turning right	13,600	11,200
Vehicle turning left	17,100	11,200
Vehicle backing	20,600	11,200
All others	14,500	11,200
Not stated	11,200	11,200

TABLE 7. RELATIVE SEVERITY INDEX (Continued)

<u>Type of Accident</u>	<u>RSI</u>	
	<u>Urban</u>	<u>Rural</u>
<u>Single Vehicle, at Intersection</u>		
Collision with train	\$ 26,700	\$ 39,100
Collision with bicycle	13,100	31,900
Injury in vehicle, jackknifed	5,200	2,000
Collision with fixed object in road	5,500	7,000
Overtaken in road	9,200	7,500
Left road	5,200	12,300
<u>Single Vehicle, Non-Intersection</u>		
Collision with train	\$ 26,700	\$ 39,100
Collision with bicycle	13,100	31,900
Injury in vehicle, jackknifed	5,200	2,000
Collision with fixed object in road	6,300	9,200
Overtaken in road	10,000	9,400
Left road at curve	7,600	12,400
Left road on straight road	5,200	10,500
<u>Other One Motor Vehicle, At Intersection and Non-Intersection</u>		
Fell from moving vehicle	\$ 15,000	\$ 57,200
Collision with animal	4,800	1,800
Collision with other object	4,700	4,400
All others	5,200	2,000
Not stated	3,200	3,400

value for a particular location is not directly dependent on whether an accident is a personal injury accident or involves a fatality. The average number of fatalities, injuries, and property damage for all accidents within a category were taken into consideration when the RSI values were developed. In this manner a random accident involving a fatality is not over-emphasized.

Figure 4, at the end of this chapter, shows the relationship between average relative severity index and indicator value.

2.5.4. Indicator 4: Volume/Capacity Ratio

The volume/capacity ratio as used here takes the following form:

$$\frac{V}{C} = \frac{ADT}{(24 \text{ Hour Capacity})}$$

The capacity, as used in the equation, is actually equal to the service volume at level C, as defined in the Highway Capacity Manual. While this is not the standard expression for the volume/capacity ratio, it does provide an idea of the average use of the facility throughout the day and gives emphasis to ADT.

Figure 5, at the end of this chapter, shows the relationship between V/C ratio and indicator value.

2.5.5. Indicator 5: Sight Distance

Sight distance is an obvious indicator of the hazardousness of a particular location. This indicator also does not rely on accident records but is a function of the roadway environment and geometry.

The data used to determine this indicator is the ratio of sight distance present to that specified as desirable in the appropriate AASHTO guides for the type of location involved. Actual sight distances were measured in the field in some cases.

For a non-intersection location the minimum desirable sight distance is the safe stopping sight distance (SSSD) on approaches to the potential hazard.

A sight distance ratio indicator must be determined for each approach to a hazardous location. However, a single indicator value must be determined for a particular location for use in the hazard index formula. To accomplish this, the FHWA report recommends that a weighted average of the two highest indicator values be used as the indicator value for that location. The highest Indicator Value would be weighted 2.0 and the next highest value weighted 1.0.

Figure 6, at the end of this chapter, shows the relationship between sight distance ratio and indicator value.

2.5.6. Indicator 6: Driver Expectancy

Driver expectancy relates to the readiness of the driver to respond to events, situations, or the presentation of information. It is a subjective parameter which attempts to deal with the drivers experience rather than an event or the roadway. For example, horizontal curves immediately beyond the crest of vertical curves or stop signs around horizontal curves are locations where driver expectancy contributes to the hazardousness of a location.

The data input for this indicator is a driver expectancy problems rating for each approach to the site under consideration. Each site was visited by three individuals, and the average of the values assigned to each approach by each individual was used as the approach rating.

Figure 7, at the end of this chapter, shows the relationship between driver expectancy problems rating and indicator value.

As with the sight distance indicator, an indicator value is determined for each approach to a particular location. Then the weighted average of the two highest indicator values is determined and this value is used as the indicator value for that location. The highest indicator value is weighted 2.0 and the next highest value is weighted 1.0.

2.5.7. Indicator 7: Information System Deficiencies

This is a subjective indicator of the adequacy of the systems at a location to enable the driver to make correct judgements and decisions. An inadequate information system creates a hazardous situation.

The data input for this indicator is an information system deficiencies rating for each approach to the site under consideration. As with the driver expectancy problems rating, each approach was rated by three individuals and the average of these ratings was used as the approach rating. The information system deficiencies rating form provides for rating each approach on a scale from 0 (excellent) through 6 (critical).

Figure 8, at the end of this chapter, shows the relationship between information system deficiencies rating and indicator value. An indicator value is determined for each approach and the weighted average of the two highest values is used as the indicator value for that location again using weighting factors of 2.0 and 1.0 respectively.

2.6. PRELIMINARY DESIGN AND CALCULATION OF COST FACTOR

After analysis of the accident data and a study of the existing conditions, recommended improvements were designed for short term improvements. Short term improvements generally include signing, striping or placement of guardrail and projects which can

normally be completed by county forces and do not necessarily require a construction contract. Short term improvements do not require right-of-way. Long term improvements are generally projects requiring reconstruction or realignment of a curve or intersection and generally require a construction contract and sometimes additional right-of-way.

Improvement costs, shown in Appendix B, were computed based on unit prices outlined in a 06 March 1987 letter from the MDOH Program Development Division to the Federal Highway Administration.

Benefits were computed based on recommendations in "Safety Engineering Improvement Program", MDOH and based on discussions with MDOH personnel familiar with the procedures. When calculating future ADT's for use in benefit calculations, it was assumed that traffic will increase approximately 7% per year, based on projections in the publication "Administrators' Highway Safety Awards", September 1986.

A benefit/cost indicator was then calculated using the formula:

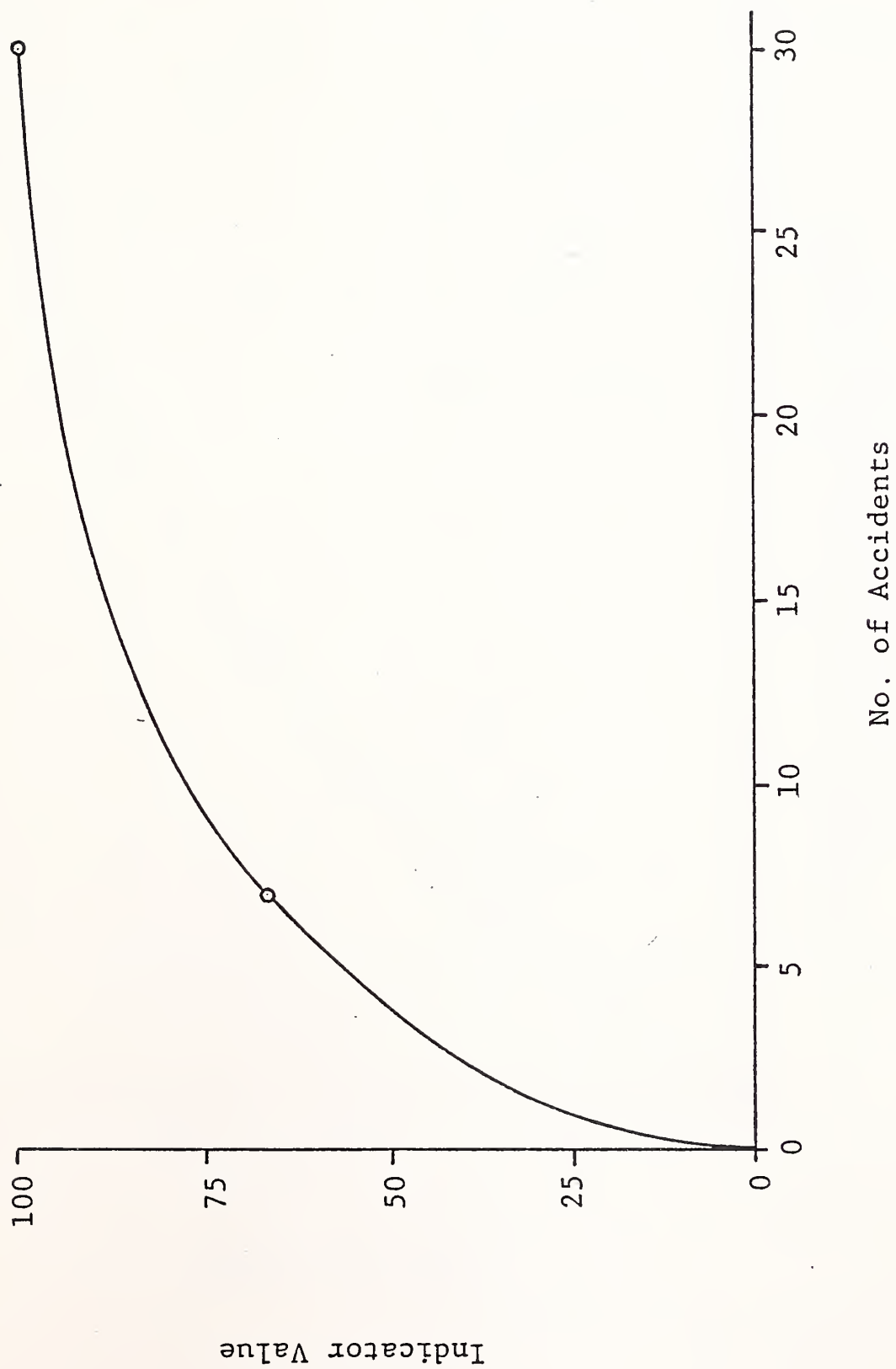
$$\text{Indicator} = 50\text{Log}(C/B)$$

Where: C = Annual Cost of Improvements
B = Annual Benefits of Improvements

2.7. ESTABLISHMENT OF PRIORITY INDEX

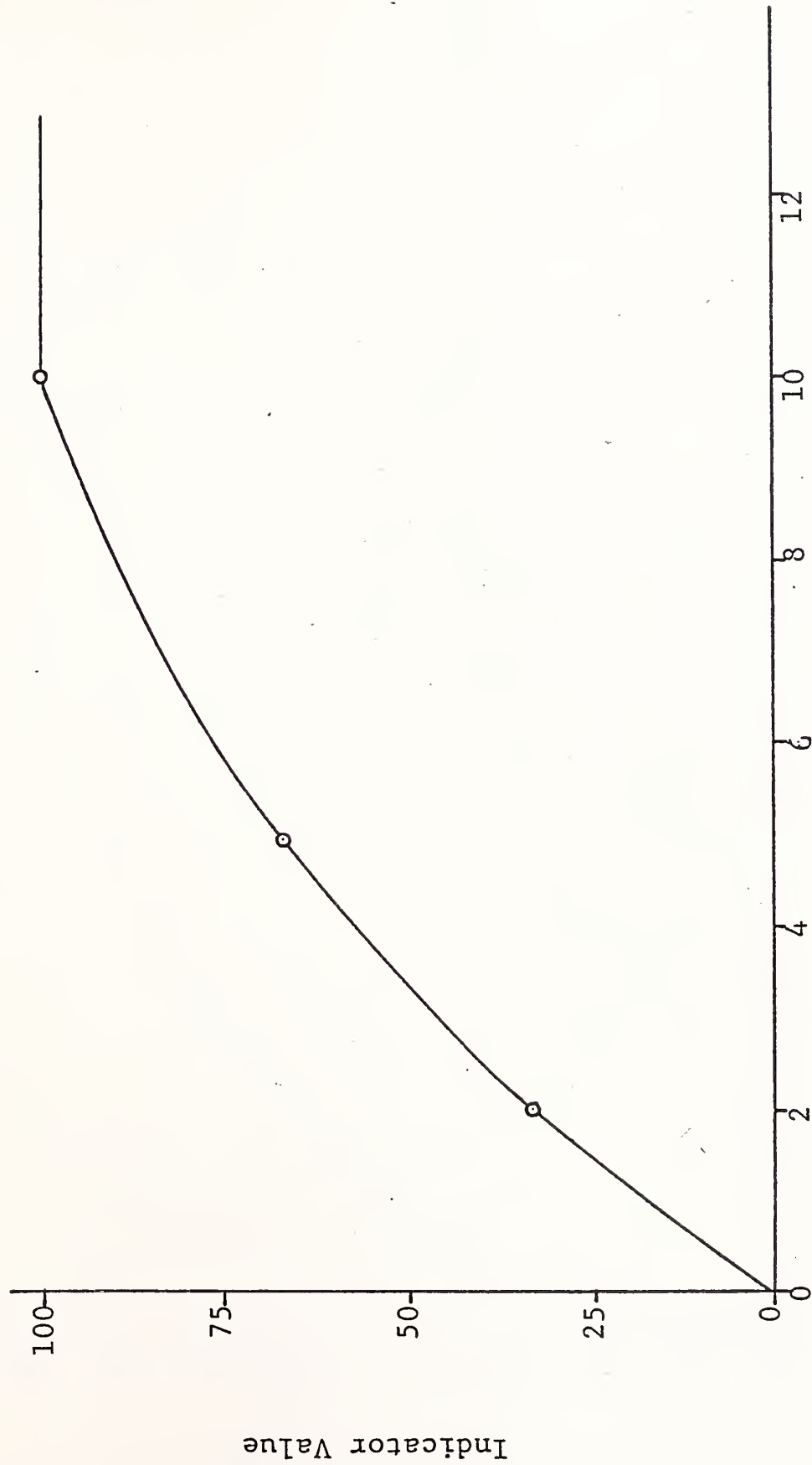
The final step in the evaluation of the hazardous locations was to develop a priority index (P.I.) for each location. The priority index is a weighted average of the hazard index and the cost factor. The hazard index was weighted 0.75 and the cost factor was weighted 0.25. The priority index formula thus takes the following form:

$$\text{P.I.} = 0.75 (\text{H.I.}) + 0.25 (\text{B/C F})$$



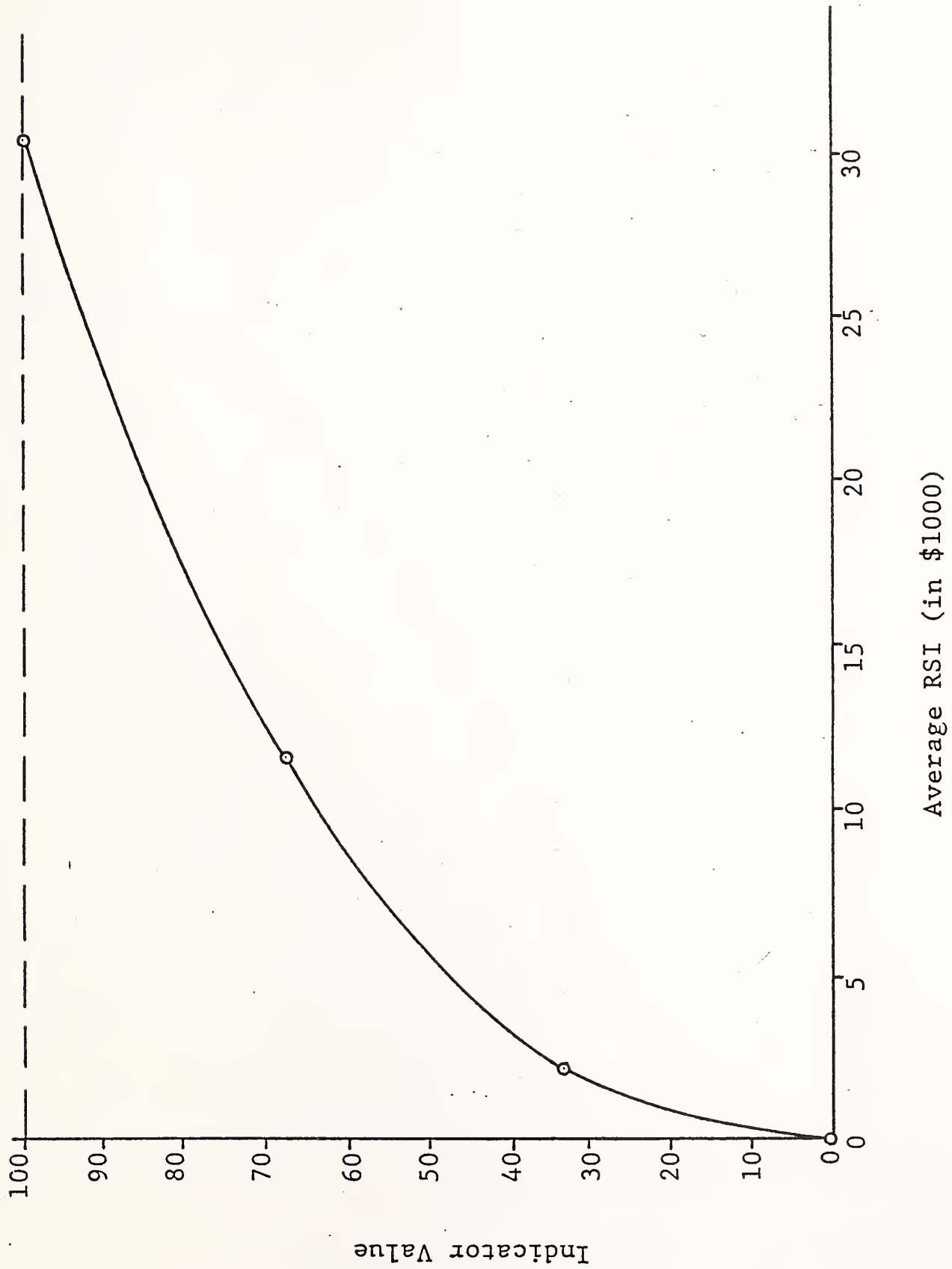
Indicator Values for Number of Accidents.

FIGURE 2



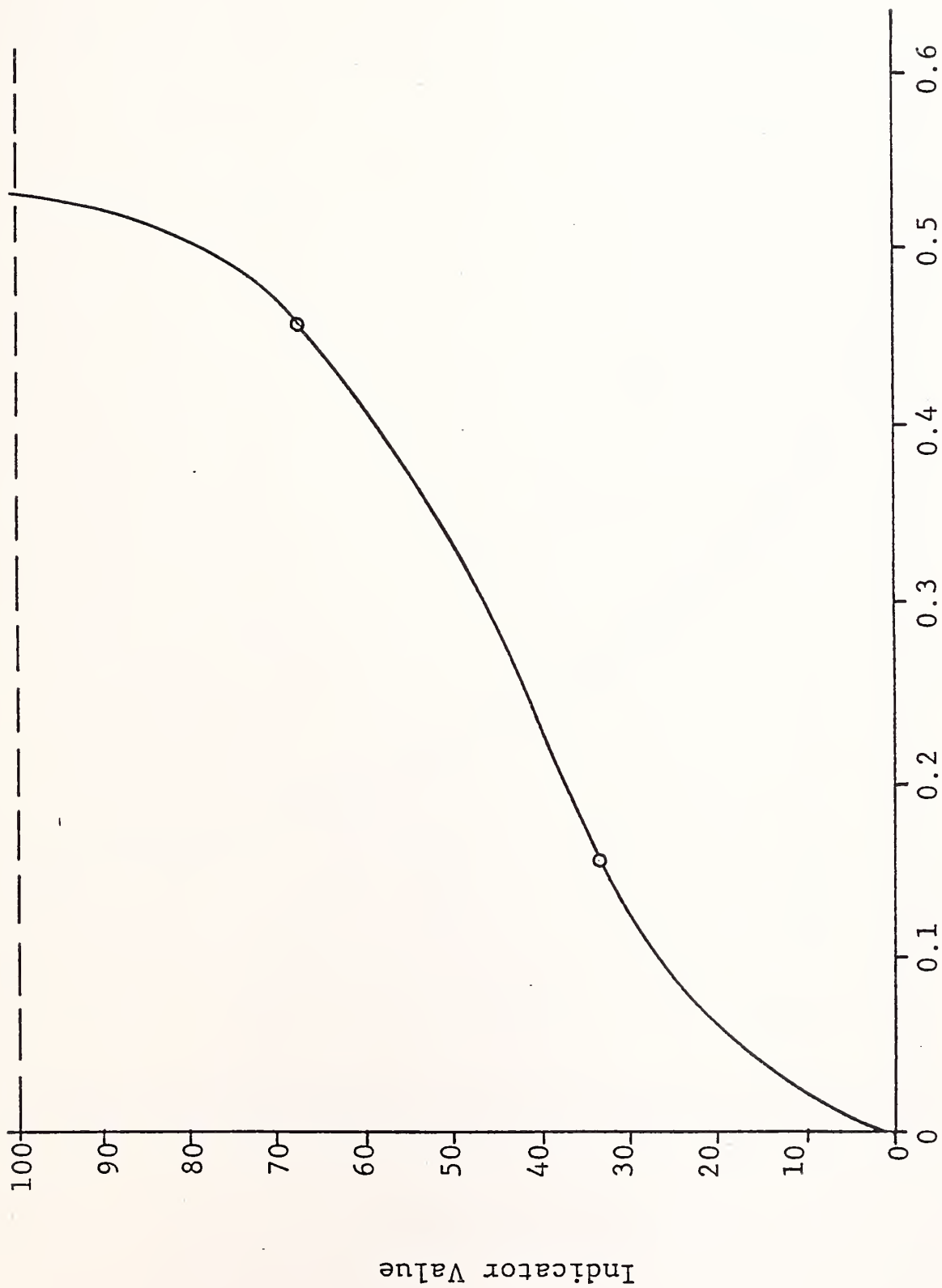
Accidents per Million Entering Vehicles
Indicator Values for Accident Rate.

FIGURE 3



Indicator value for accident severity.

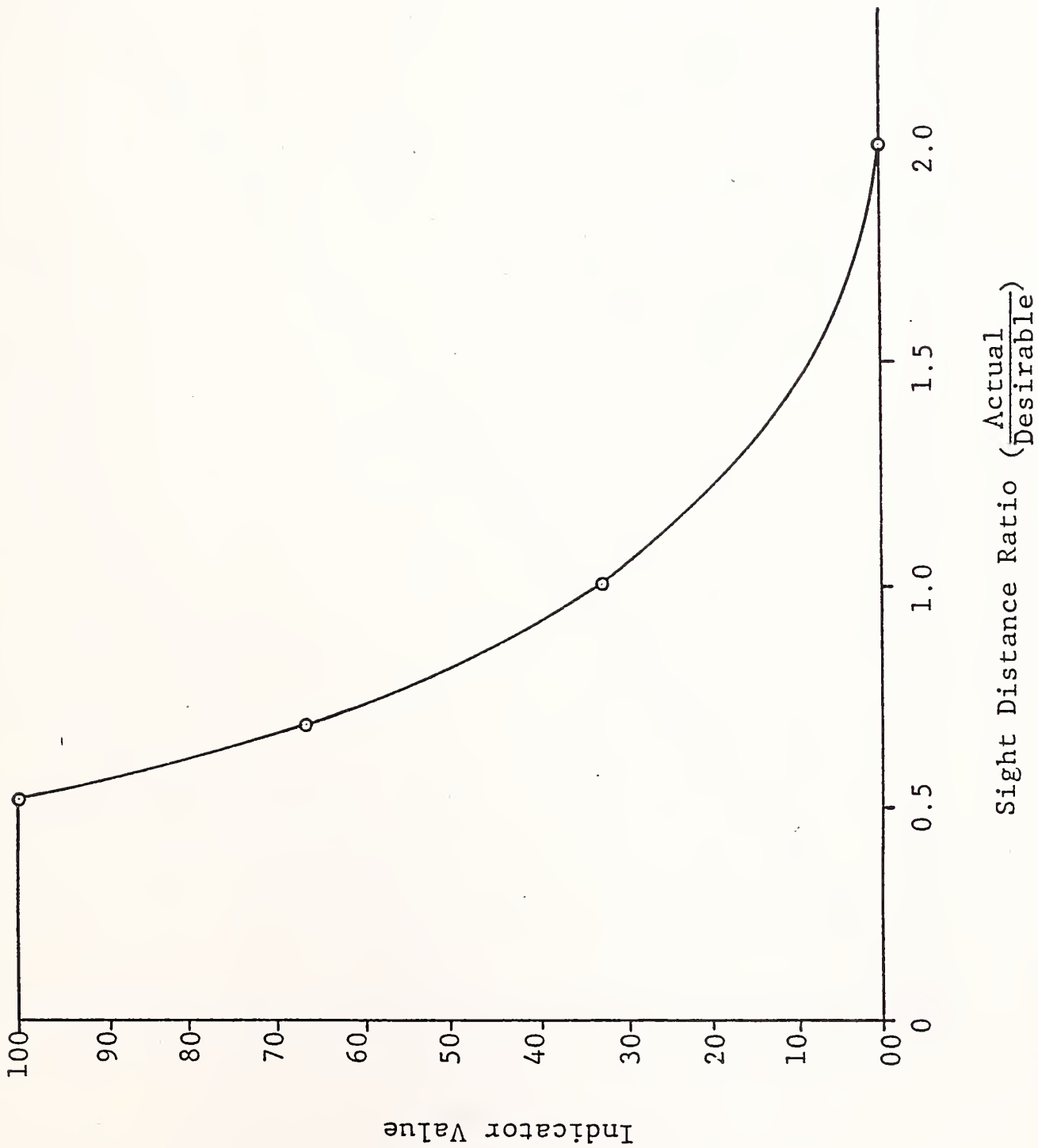
FIGURE 4



V/C Ratio

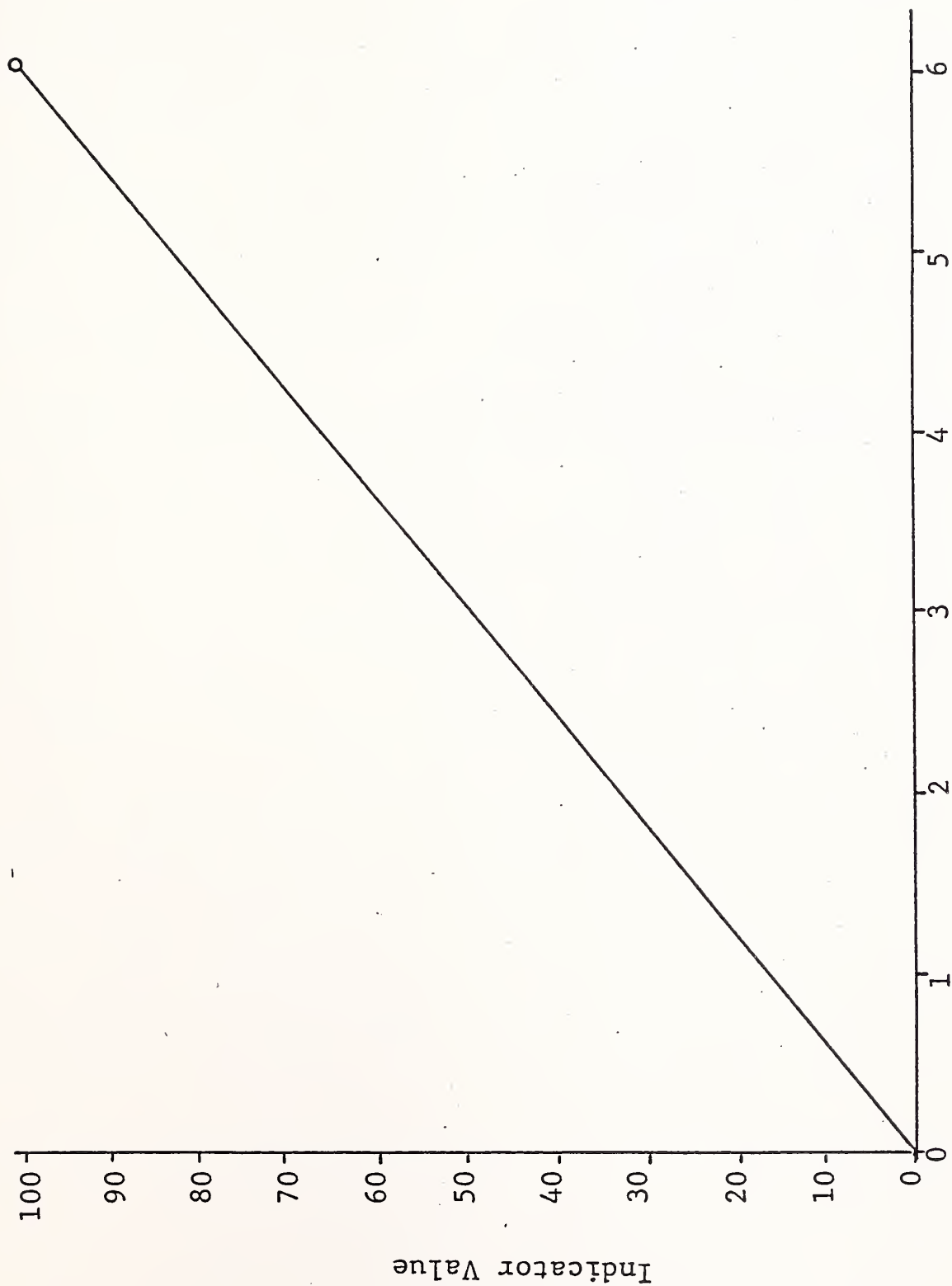
Indicator values for V/C ratio.

FIGURE 5



Indicator values for sight distance.

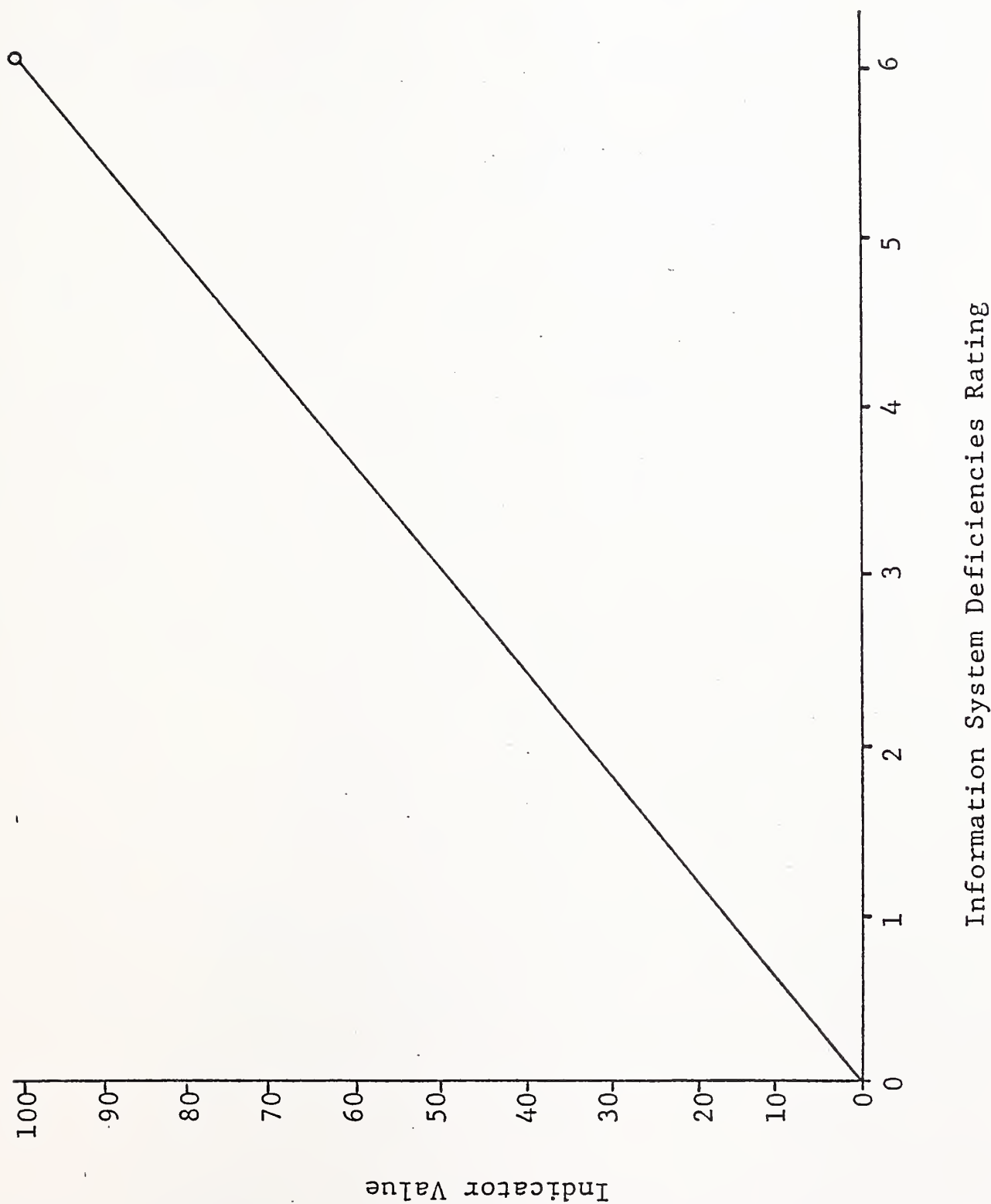
FIGURE 6



Driver Expectancy Problems Rating

Indicator values for driver expectancy.

FIGURE 7



Indicator values for information system deficiencies.

FIGURE 8

3. SITE ANALYSIS, SITES 1 THRU 10

3.1. SITE 1

3.1.1. Location

Site 1 includes the two sharp curves on Cottonwood Road just east of the intersection of Cottonwood Road and Cottonwood Creek Road in Section 21, Township 3 South, Range 5 East.

3.1.2. Existing Conditions

The roadway in this area is gravel surfaced and is generally 22 feet wide. The surface becomes corrugated toward the end of the grading cycle. Vertical grades, as shown on the profile, vary from about 1 percent to near 9 percent. The radius of both curves is approximately 120 feet. ADT was determined to be about 420 vehicles per day and is based on 24 hour machine counts performed in August 1987. Truck traffic is estimated to be 10%.

Using guidelines included on page 166 of the AASHTO "Green Book", it was determined using a ball-bank indicator that safe speeds on both curves for vehicles traveling south is 15 mph and for vehicles traveling north, 20 mph.

Existing signing for the two curves includes two Turn Signs (W1-1), one just ahead of each approach to the curves, and a Large Arrow Sign (W1-6), to delineate the north curve for traffic approaching from the north. Both Turn Signs are mounted too low. Deciduous trees and brush exist behind the arrow sign and may affect it's visibility during the daytime, particularly during the fall when leaves are near the same color as the sign.

Sight distance, for the north curve as viewed by traffic approaching from the north is approximately 190 feet. Sight distance for all other curve approaches is greater than twice the recommended safe stopping sight distance.

3.1.3. Accident History and Analysis

There were six reported accidents at this site during the period 1980 to 1986. Five of the six involved southbound traffic, which is also downhill traffic in the area of the curves. Three of the six accidents were on the north curve. Five of the accidents involved vehicles out of control but only 2 were on roadways that were snow covered or icy. Three of the accidents were after dark.

3.1.4. Short Term Improvements

It is recommended that the following short term improvements be performed:

1. It is estimated that the 85th Percentile Speed of vehicles approaching the site is 45 mph. Table II-1 of the MUTCD therefore recommends turn sign placement a minimum of

300 before the hazard. The existing Turn Sign (W1-1) on the south curve can therefore remain where it is, but it should be raised to the proper height and a 20 mph Advisory Speed Plate (W13-1) should be added. The existing Turning Sign (W1-1) on the north curve is less than 300 feet from the curve. It is recommended it be relocated as shown on the site sketch and that 20 mph Advisory Speed Plate be added.

2. Add two additional Turn Signs (W1-1) at the locations shown to provide additional warning that another curve follows the first curve. The two curves are approximately 850 feet apart.

3. Add a Hill Sign (W7-1 or W7-1b). Since most of the accidents have involved vehicles going down hill, this may provide additional warning of the combination of hazardous conditions at the site. It should be placed approximately 200 feet ahead of the Turn Sign, as shown on the site sketch.

4. Leave the Large Arrow Sign (W1-6) as-is. Periodically, this sign should be checked, both at day and at night to assure that the sign is visible at the appropriate distances and that the color of brush and other background materials behind the sign do not cause it to blend into it's surroundings.

5. Add delineators at the locations shown.

3.1.5. Long Term Improvements

Recommend long term improvements include purchasing additional right-of-way and widening the curves to provide a higher design speed.

Recommended future maintenance practices to help alleviate potential hazardous conditions include grading to assure that proper superelevation is maintained and placement of gravel with a gradation that will resist the formation of corrugations and provide maximum skid resistance. Regular removal of brush and weeds near the roadway may also make the curves more visible and will help maintain the high visibility of warning signs.

ACCIDENT DATA

SITE NUMBER 1

PERIOD FROM 1980 TO 1986

NUMBER OF ACCIDENTS BY YEAR

80	81	82	83	84	85	86
		1	1		3	1

NUMBER OF ACCIDENTS BY DAY OF WEEK

SUN	MON	TUE	WED	THU	FRI	SAT
				3		3

NUMBER OF ACCIDENTS BY MONTH

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2	1			2			1				

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

DRY	WET	SNOW	ICE	OTHER
4			2	

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

CLEAR	RAIN	SNOW	FOG	OVERCAST
3		1		2

NUMBER OF ACCIDENTS
BY LIGHT CONDITIONS

DAYLIGHT	DARK	DUSK	DAWN
3	3		

NUMBER OF ACCIDENTS BY SEVERITY

	80	81	82	83	84	85	86
INJURIES							
FATALITIES							
P. D. O.			1	1		3	1

NUMBER OF ACCIDENTS
BY NUMBER OF INJURIES

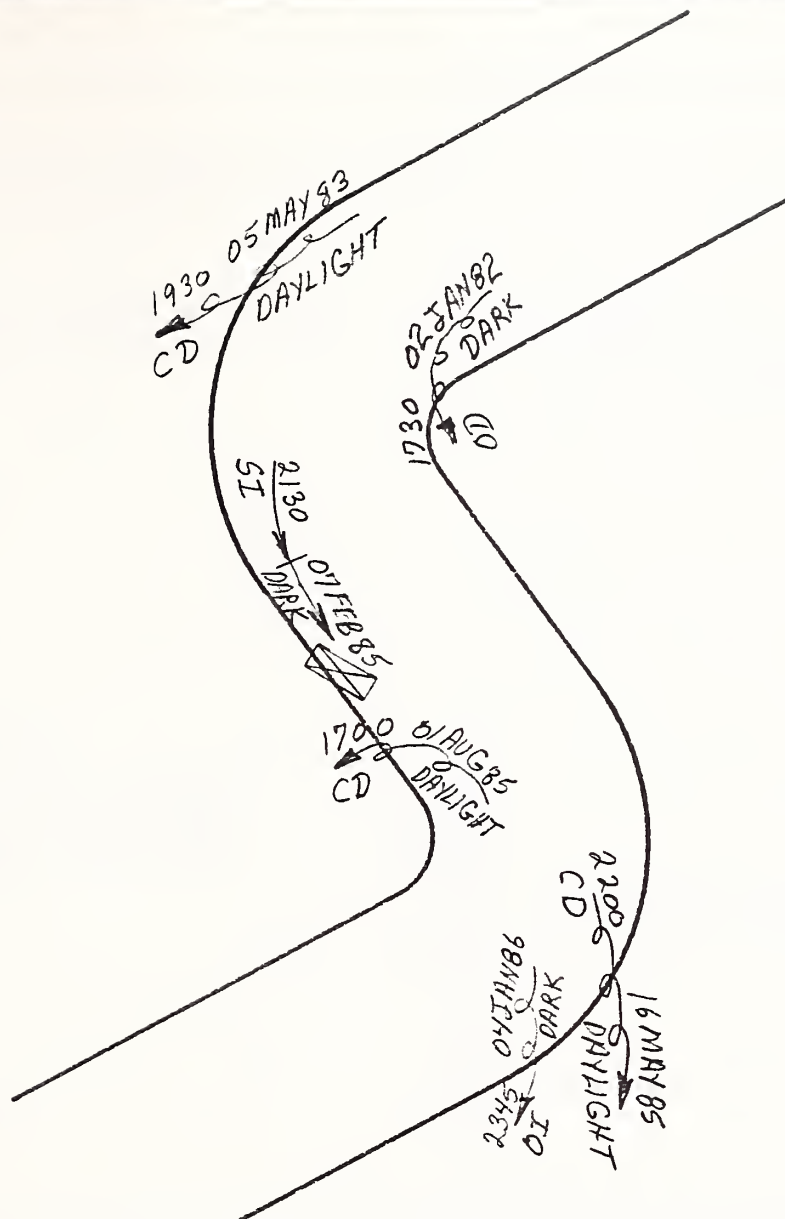
0	1	2	3	4	5
6					

NUMBER OF ACCIDENTS BY NO. OF FATALITIES

0	1	2	3	4	5
6					

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

ANGLE	LT - TURN	R - END	FX - OBJ	PED	ANIMAL	SDSWP	NON - COL	HD - ON
		1					5	



SYMBOLS

- ← VEHICLE PATH
- ← PEDESTRIAN PATH
- ↔ BACKING VEHICLE
- ☒ PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION TYPE

- ↔ REAR END
- ↔ HEAD ON
- ↔ SIDESWIPE
- ↔ OUT OF CONTROL
- ↔ RIGHT ANGLE
- ↔ LEFT TURN

CONDITIONS

TIME: 1500
 WEATHER: R V
 PAVEMENT: R V
 DATE: 08 AUG 85
 LIGHT: DARK

WEATHER: O = Overcast
 R = RAIN, F = FOG,
 C = CLEAR, S = SNOW

PAVEMENT:
 D = DRY, W = WET, I = ICY

LOCATION: COTTONWOOD CREEK ROAD, SEC 21, T3S, R5E

PERIOD: SEVEN YEARS

FROM: 1980

TO: 1986

PREPARED BY: PETERSON

DATE: AUGUST 1987

SITE 1

DETERMINATION OF BENEFITS AND COSTS

SITE _____ 1

Estimated 5 Year Service Life
Interest Rate = 10%

1987 ADT 416
7 Years Accident Data

ANNUAL COST *****

Capital Cost =	1060
K=0.264	.264
M = 0	0
Annual Cost =	280

ANNUAL BENEFIT *****

1992 ADT (7% FOR 5 YEARS)	583	
COST PER FATAL ACCIDENT	240000	
COST PER INJURY ACCIDENT	10800	
COST OF PD ACC	1600	
I/F	19	SECONDARY ROADS
Q	22300	
Afi	.0	
Apd	.7	
Pfi	.52	
Ppd	.52	
ANNUAL BENEFIT	817	
B/C	2.9	
INDICATOR VALUE	23	

DETERMINATION OF HAZARD INDEX

Site No.: 1

Indicator	Data Value		Indicator Value	Weight	Partial H.I.
-----	-----		-----	-----	-----
Number of Accidents	.9	acc/yr	24 X	.164 =	3.9
Accident Rate	5.6	acc/mev	73 X	.225 =	16.4
Accident Severity	11.7	\$1000	68 X	.191 =	13.0
V/C Ratio	.35		52 X	.082 =	4.3
Sight Distance Ratio	.56		90 X	.074 =	6.7
Driver Expectancy	2.0	Rating	33 X	.149 =	5.0
Information System Deficiencies	1.8	Rating	30 X	.115 =	3.5

Hazard Index (HI)					53

Benefit/Cost Indicator (BCI) 23

Priority Index = HI X 0.75 + BCI X 0.25 = 46

NORTH CURVE

SITE OF PAST
OVERTURNING &
SKIING MISHAPS

QUANTITIES

2 - W1-1 (30' x 30')
1 - W7-1 (30' x 30') W7-1P
4 - 4" Ø POLE @ 14'
18 - DESIGN "F" FLEXIBLE DELIN.
POSTS H (See Spec. Prov.)
4 - W13-1 (18' x 18')

LEGEND

- ☐ Mailbox
- ☐ Telephone Box
- Power Pole
- ☐ Sign as Described
- ✓ Guy Wire
- Existing Elevation
- End Post
- Fence
- Post; Support Pole

NOTE: COTTONWOOD ROAD IS
WASH BOARD GRAVEL;
SOUTH CURVE IS MOVING
CLOSER TO FENCE

SITE NO. 1

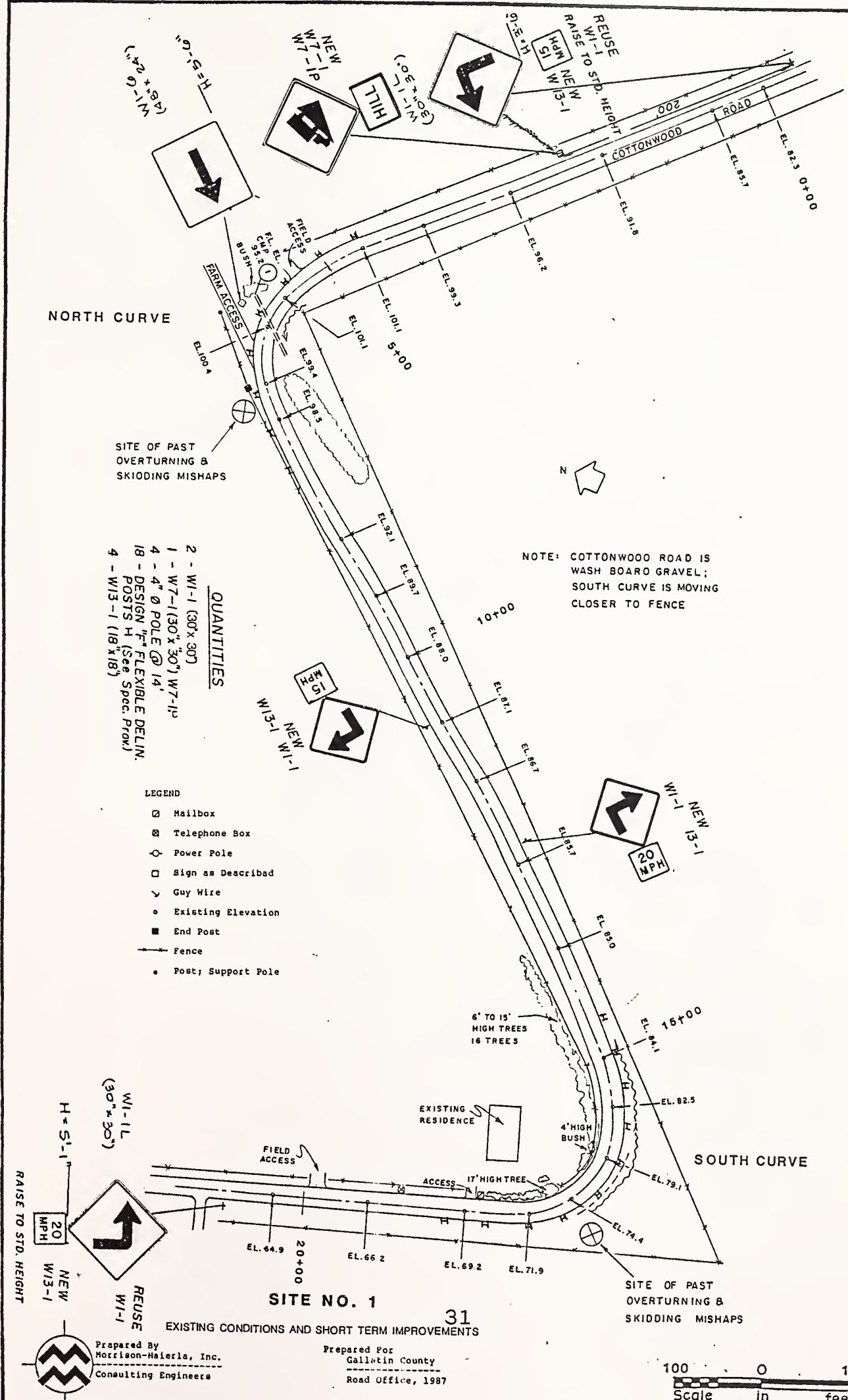
31

EXISTING CONDITIONS AND SHORT TERM IMPROVEMENTS

Prepared By
Harrison-Haierla, Inc.
Consulting Engineers

Prepared For
Gallatin County
Road Office, 1987

100 0 100
Scale in feet





32

SITE 2 - WEST

3.2. SITE 2W

3.2.1. Location

Site 2W is located at the 90 degree curve of South 3rd Avenue, approximately 600 feet west of Site 2E (the intersection of South 3rd and Goldenstein) in Section 25, Township 2 South, Range 5 East.

3.2.2. Existing Conditions

All roadways are paved. Grades are uniform and essentially flat. The radius of the curve is approximately 155 feet.

Existing signing includes two Turn Signs (W1-1) with 25 mph Advisory Speed Plates (W13-1), a Large Arrow Sign (W1-6) that has poor reflectorization and three Chevron Signs (W1-8). A Speed Limit 35 Sign (R2-1) is located north of the site. The Turn and Advisory Speed Plate Sign south of the site is partially obscured by a bank of mailboxes to the south. The Large Arrow Sign is backed by trees and brush which, during the fall, are nearly the same color. The Large Arrow Sign is not placed directly in line with approaching traffic.

Sight distance is more than twice the recommended safe stopping sight distance.

Using guidelines included on page 166 of the AASHTO "Green Book", it was determined using a ball-bank indicator that safe speeds on the South 3rd curve are 25 mph for either direction of travel, in agreement with existing advisory speed plates.

The estimated ADT, based on 24 hour machine counts in August 1987 is 1050 vpd.

Truck traffic is estimated to be 10%.

3.2.3. Accident History and Analysis

Seven accidents have occurred at this intersection during the past 7 years. All have involved out of control vehicles failing to negotiate the curve. Four of the accidents were after dark or at dawn. None of the accidents at this site included injuries.

3.2.4. Short Term Improvements

The following short term improvements are recommended:

1. Remove and replace the existing poorly reflectorized Large Arrow Sign (W1-6) and re-install in line with the traffic lane approaching from the south.
2. Add one Chevron Sign (W1-8) and relocate at least one of the existing three, as indicated on the site sketch. The location of all 4 Chevron Signs should be reviewed carefully in the field as installation occurs. As indicated in Section 2C-10 of the MUTCD, trial runs by day and night may

be desirable to determine final positioning. The signs should be in line with and at right angles to approaching traffic.

3. The bottom of the Turn Sign (W1-1) on the east approach is at approximately 4' - 5" above the shoulder of the road. It should be raised.

4. The Turn Sign (W1-1) and Advisory Speed Plate (W13-1) on the south approach should be raised and/or relocated so that they are not obscured by the mailboxes to the south.

3.2.5. Long Term Improvements

Brush should be cleared regularly and as much as possible within the right-of-way around the Large Arrow Sign to provide a clear view and unobstructed background.

The county has indicated that, within the next 2 to 3 years, a road will be extended west to connect with existing roads nearer to Bozeman. Traffic patterns will change significantly and traffic volumes at the site may increase. Recommendations for this future construction are beyond the scope of this study and report.

ACCIDENT DATA

SITE NUMBER 2 W.

PERIOD FROM 1980 TO 1986

NUMBER OF ACCIDENTS BY YEAR

80	81	82	83	84	85	86
1	2	2				2

NUMBER OF ACCIDENTS BY DAY OF WEEK

SUN	MON	TUE	WED	THU	FRI	SAT
	2			1	3	1

NUMBER OF ACCIDENTS BY MONTH

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1							1			4	1

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

DRY	WET	SNOW	ICE	OTHER
2	2		5	

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

CLEAR	RAIN	SNOW	FOG	OVERCAST
4		1		2

NUMBER OF ACCIDENTS
BY LIGHT CONDITIONS

DAYLIGHT	DARK	DUSK	DAWN
1	4		2

NUMBER OF ACCIDENTS BY SEVERITY

	80	81	82	83	84	85	86
INJURIES							
FATALITIES							
P. D. O.	1	2	2				2

NUMBER OF ACCIDENTS
BY NUMBER OF INJURIES

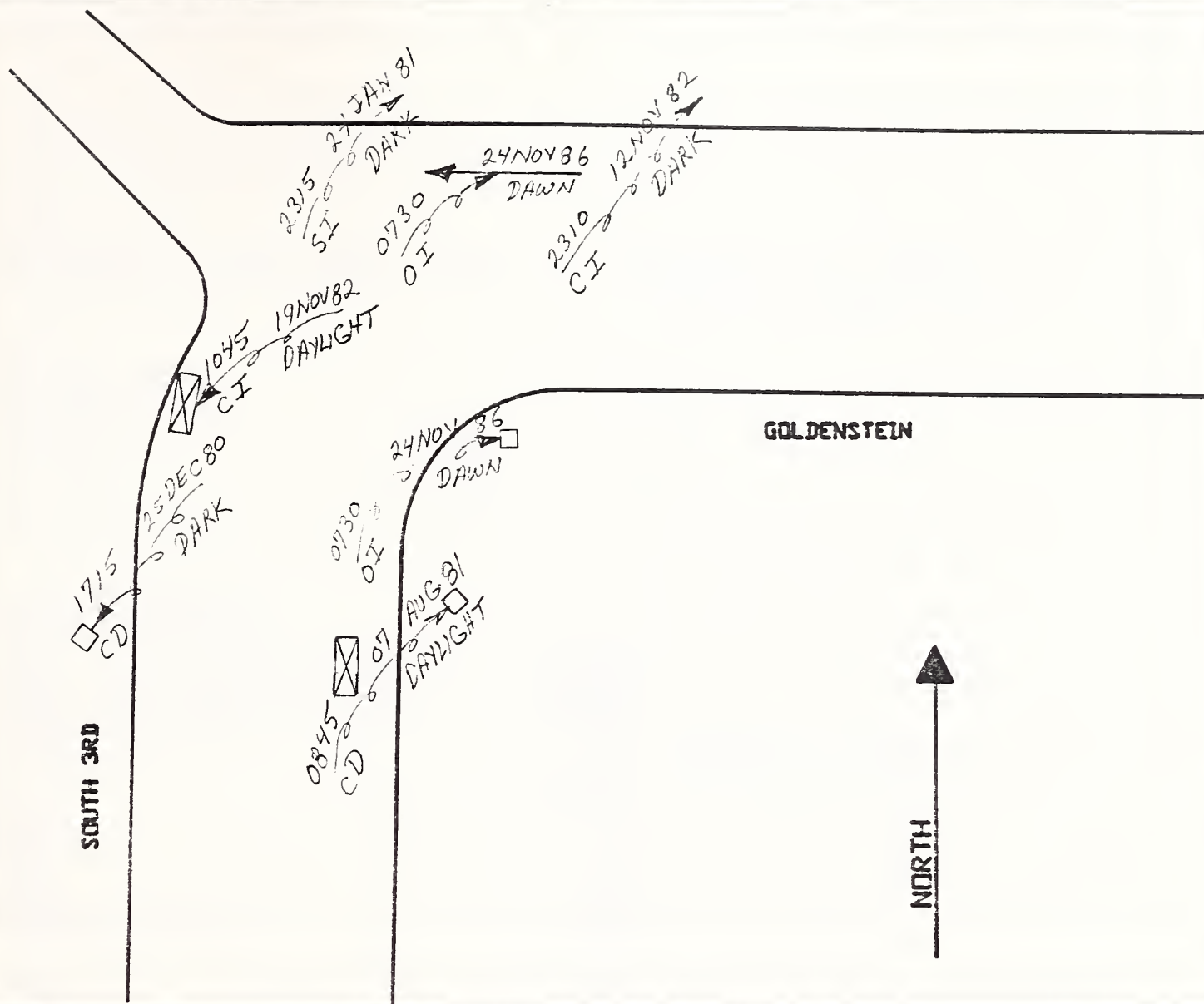
0	1	2	3	4	5
7					

NUMBER OF ACCIDENTS BY NO. OF FATALITIES

0	1	2	3	4	5
7					

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

ANGLE	LT - TURN	R - END	FX - OBJ	PED	ANIMAL	SDSWP	NON - COL	HD - ON
			3			1	3	



SYMBOLS

- ← VEHICLE PATH
- ← PEDESTRIAN PATH
- ↔ BACKING VEHICLE
- ⊠ PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION TYPE

- ↔ REAR END
- ↔ HEAD ON
- ↔ SIDESWIPE
- ↔ OUT OF CONTROL
- ↔ RIGHT ANGLE
- ↔ LEFT TURN

CONDITIONS

TIME → 1500
 DATE → 08 AUG 85
 WEATHER → R V
 PAVEMENT → DARK

WEATHER:

R = RAIN, F = FOG,
 C = CLEAR, S = SNOW

PAVEMENT:

D = DRY, W = WET, I = ICY

LOCATION: SOUTH 3RD AVENUE, SEC 25, T2S, R5E

PERIOD: SEVEN YEARS

FROM: 1980

TO: 1986

PREPARED BY: PETERSEN

DATE: AUGUST 1987

SITE 2

DETERMINATION OF BENEFITS AND COSTS

SITE ____ 2W

Estimated 5 Year Service Life
Interest Rate = 10%

1987 ADT 1050
7 Years Accident Data

ANNUAL COST

Capital Cost =	780
K=0.264	.264
M = 0	0
Annual Cost =	206

ANNUAL BENEFIT

1992 ADT (7% FOR 5 YEARS)	1473	
COST PER FATAL ACCIDENT	240000	
COST PER INJURY ACCIDENT	10800	
COST OF PD ACC	1600	
I/F	19	SECONDARY ROADS
Q	22300	
Afi	.0	
Apd	1.0	
Pfi	.45	
Ppd	.45	
ANNUAL BENEFIT	1010	
B/C	4.9	
INDICATOR VALUE	35	

DETERMINATION OF HAZARD INDEX

Site No.: 2W

Indicator	Data Value		Indicator Value		Weight	Partial H.I.
-----	-----		-----		-----	-----
Number of Accidents	1.0	acc/yr	26	X	.164 =	4.3
Accident Rate	2.6	acc/mev	43	X	.225 =	9.7
Accident Severity	12.0	\$1000	69	X	.191 =	13.2
V/C Ratio	.22		39	X	.082 =	3.2
Sight Distance Ratio	2.0		0	X	.074 =	
Driver Expectancy	2.9	Rating	48	X	.149 =	7.2
Information System Deficiencies	2.9	Rating	48	X	.115 =	5.6
Hazard Index (H.I.)						----- 43

Benefit/Cost Indicator (BCI) 35

Priority Index = HI X 0.75 + BCI X 0.25 = 41

SITE 2 - EAST

3.3. SITE 2E

3.3.1. Location

Site 2E is located at the intersection of South 3rd and Goldenstein (approximately 600 feet east of Site 2W) in Section 25, Township 2 South, Range 5 East. The intersection includes a stop condition for traffic approaching on Goldenstein from the east with through traffic between the north leg (South 3rd, north) and the west leg (South 3rd, west) of the intersection.

3.3.2. Existing Conditions

All roadways are paved. Grades are uniform and essentially flat. Travel between the north leg and the west leg, the thru movements, involves a sharp, less than 50 foot radius curve with inadequate superelevation.

Existing signing includes two 24" X 24" Curve Signs (W2-1), one on the west approach to the curve (shown on the site sketch for Site 2W and one on the north approach. The east approach is controlled by a Stop Sign (R1-1).

Sight distance is more than twice the recommended safe stopping sight distance.

Using guidelines included on page 166 of the AASHTO "Green Book", it was determined using a ball-bank indicator that safe speeds on the South 3rd curve are 15 mph for either direction of travel.

Estimated ADT's, based on 24 hour machine counts in August 1987 are:

North Leg	1630
East Leg	580
West Leg	1050

Truck traffic is estimated to be 10%.

3.3.3. Accident History and Analysis

Five accidents have occurred at this intersection during the past 7 years. Four have involved out of control vehicles failing to negotiate the curve. One involved poor visibility and a driver cutting the curve too sharp and entering the lane of an opposing vehicle. Of the four out of control vehicles, 3 were approaching the intersection from the west, attempting to make the left turn to proceed north on South 3rd. Four of the accidents were after dark with the fifth being the poor visibility condition described above. Four of the 5 accidents at this site included injuries.

3.3.4. Short Term Improvements

The following short term improvements are recommended:

1. Install a Guide Sign with a directional arrow on the west approach to the intersection to help advise drivers of the approaching left turn to South Third Street. This may help to remove uncertainty and last minute attempts to negotiate the left turn to go north.
2. Replace the existing Curve Signs (W2-1) with Turn Signs (W1-1).
3. Add 15 mph Advisory Speed Plates (W13-1), to coincide with the recommended speed around the curves.
4. Add a Large Arrow Sign (W1-6) at the top of the "T" to help delineate the sharp right turn for vehicles approaching from the north.
5. Add delineators as shown.

3.3.5. Long Term Improvements

As indicated above, 4 of the 5 accidents involved injuries. One involved a collision with the power pole in the northeast quadrant of the intersection. To help reduce the severity of accidents, it is recommended that this power pole be relocated. Also, there are several large trees approximately in line with traffic approaching from the north which should be removed to help provide a safe recovery area for errant vehicles.

Intersections on sharp curves, such as this one, are generally not desirable. The following two long term improvements should be considered:

1. Make the intersection a "T" intersection. With this option, traffic approaching on South 3rd from the north would be required to stop. Traffic from the east or west would be through. The advantage of this option is that it will not require extensive reconstruction of the roadway embankments and pavements. It should also not require additional right-of-way. The disadvantage is the potential negative public opinion due to the perceived added inconvenience for traffic between the north and west legs of the intersection, the current major traffic movements.
2. Increase the radius of the curve between the north and west legs and realign the east approach to intersect the curve at near a right angle. The advantage to this option is that it will maintain the current traffic operations. The disadvantages are that significant reconstruction and right-of-way acquisition will be required.

ACCIDENT DATA

SITE NUMBER 2 E.

PERIOD FROM 1980 TO 1986

NUMBER OF ACCIDENTS BY YEAR

80	81	82	83	84	85	86
1	1		1		1	1

NUMBER OF ACCIDENTS BY DAY OF WEEK

SUN	MON	TUE	WED	THU	FRI	SAT
1				3		1

NUMBER OF ACCIDENTS BY MONTH

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1				1			1	1	1		

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

DRY	WET	SNOW	ICE	OTHER
2	2		1	

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

CLEAR	RAIN	SNOW	FOG	OVERCAST
3		1		1

NUMBER OF ACCIDENTS
BY LIGHT CONDITIONS

DAYLIGHT	DARK	DUSK	DAWN
1	4		

NUMBER OF ACCIDENTS BY SEVERITY

	80	81	82	83	84	85	86
INJURIES	1	1		1			1
FATALITIES							
P. D. O.						1	

NUMBER OF ACCIDENTS
BY NUMBER OF INJURIES

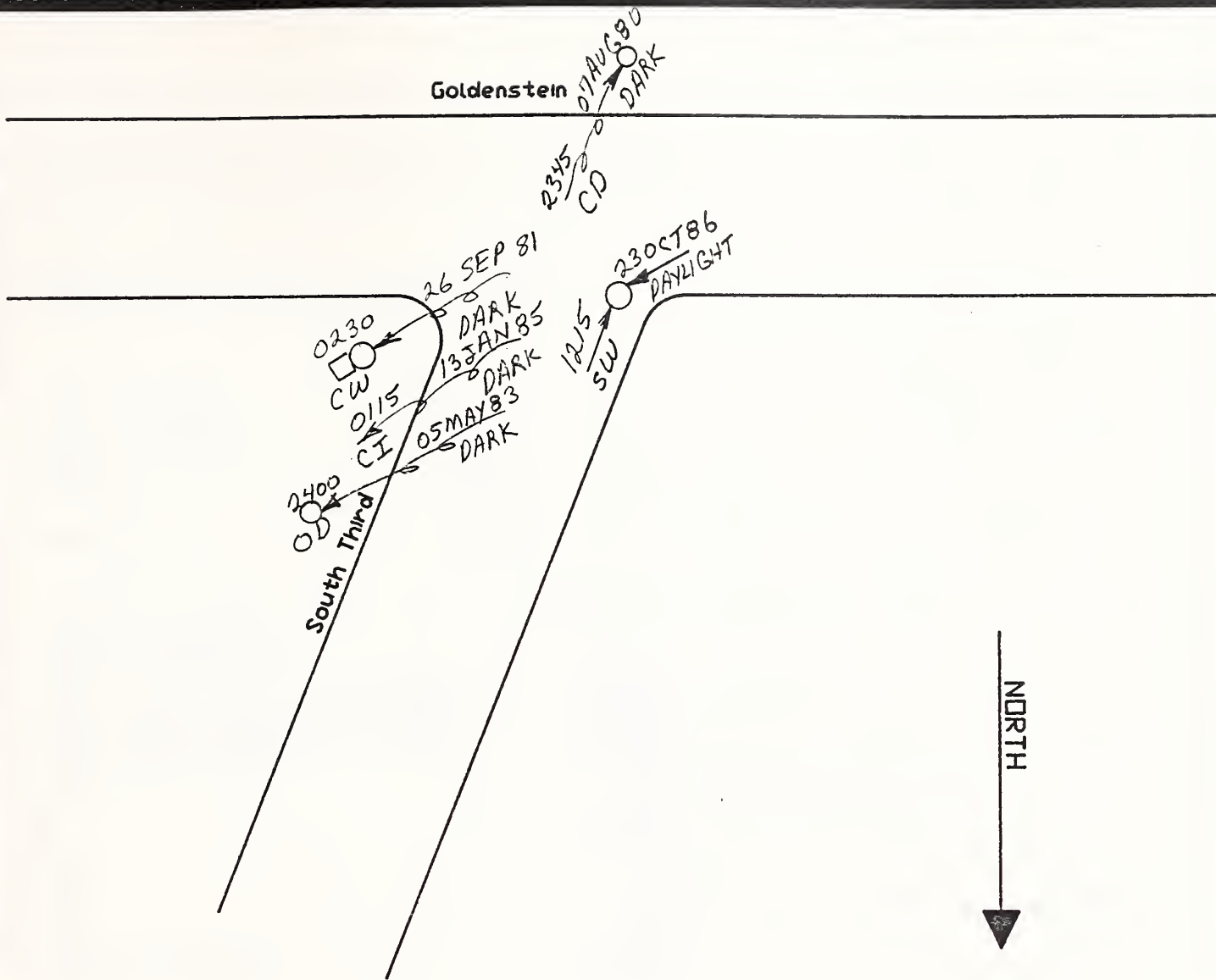
0	1	2	3	4	5
1	3	1			

NUMBER OF ACCIDENTS BY NO. OF FATALITIES

0	1	2	3	4	5
5					

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

ANGLE	LT - TURN	R - END	FX - OBJ	PED	ANIMAL	SDSWP	NON - COL	HD - ON
			1				3	1



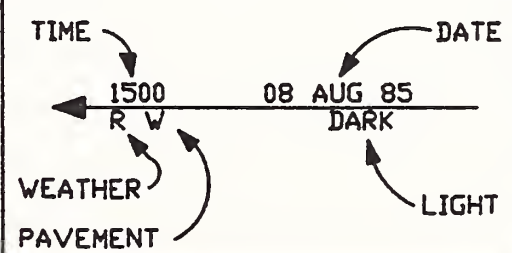
SYMBOLS

- ← VEHICLE PATH
- ← PEDESTRIAN PATH
- ↔ BACKING VEHICLE
- ⊠ PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION TYPE

- ←+ REAR END
- + HEAD ON
- ←↘ SIDESWIPE
- ←↻ OUT OF CONTROL
- ⊥ RIGHT ANGLE
- ↘→ LEFT TURN

CONDITIONS



WEATHER:
 R = RAIN, F = FOG,
 C = CLEAR, S = SNOW

PAVEMENT:
 D = DRY, W = WET, I = ICY

LOCATION: SOUTH 3RD AVENUE, SEC 25, T2S, R5E

PERIOD: SEVEN YEARS FROM: 1980

PREPARED BY: PETERSON

TO: 1986

DATE: AUGUST 1987

SITE 2
 EAST

DETERMINATION OF BENEFITS AND COSTS

SITE ____ 2E

Estimated 5 Year Service Life
Interest Rate = 10%

1987 ADT 1630
7 Years Accident Data

ANNUAL COST

Capital Cost =	660
K=0.264	.264
M = 0	0
Annual Cost =	174

ANNUAL BENEFIT

1992 ADT (7% FOR 5 YEARS)	2286
COST PER FATAL ACCIDENT	240000
COST PER INJURY ACCIDENT	10800
COST OF PD ACC	1600
I/F	19
Q	22300
Afi	.6
Apd	.1
Pfi	.53
Ppd	.53
ANNUAL BENEFIT	10065

SECONDARY ROADS

B/C	57.8
INDICATOR VALUE	88

DETERMINATION OF HAZARD INDEX

Site No.: 2E

Indicator	Data Value		Indicator Value	Weight	Partial H.I.
-----	-----		-----	-----	-----
Number of Accidents	.7	acc/yr	20 X	.164 =	3.3
Accident Rate	1.2	acc/mev	21 X	.225 =	4.7
Accident Severity	12.9	\$1000	71 X	.191 =	13.6
V/C Ratio	.22		39 X	.082 =	3.2
Sight Distance Ratio	2.0		0 X	.074 =	
Driver Expectancy	2.9	Rating	48 X	.149 =	7.2
Information System Deficiencies	2.9	Rating	48 X	.115 =	5.6
Hazard Index (H.I.)					----- 38

Benefit/Cost Indicator (BCI) 88

Priority Index = HI X 0.75 + BCI X 0.25 = 51

PROJECT NO.

[illegible]

3.4. SITE 3

3.4.1. Location

Site 1 includes the south approach of the intersection of Gooch Hill Road and US 191 in Section 16 and 17, Township 2 South, Range 5 East.

3.4.2. Existing Conditions

US 191 is the major route for traffic traveling from the Bozeman area to Big Sky Resort and Yellowstone National Park.

Gooch Hill Road is asphalt paved with generally a 24 foot pavement width. Grades are uniform and flat and sight distance is more than twice the recommended safe stopping sight distance. Gooch Hill Road, in this area, is essentially straight.

It should be noted that US 191 is scheduled for reconstruction in 1993 and will include the construction of a private approach to Gooch Hill Road as shown on the site sketch.

ADT on Gooch Hill Road is estimated to be 2900 vehicles per day based on 24 hour machine counts conducted in August 1987. The ADT on US 191 is estimated to be approximately 8000 vehicles per day based on MDOH counts just west of Gooch Hill Road.

Existing signing related to the south approach includes a Stop Sign (R1-1), an Advance Stop Warning Sign, (W3-1), an "Emergency Vehicle Entering 600 Feet" Warning Sign and Cross Road Signs (W2-1) east and west of Gooch Hill Road on US 191

3.4.3. Accident History and Analysis

There were 4 accidents recorded involving the south approach during the period 1980 to 1986. Three of the four involved vehicles approaching from the south and either out of control or rear end. No injuries were reported. Half the accidents included snow covered or icy roads and half were after dark. All were during winter months.

3.4.4. Short Term Improvements

No short-term improvements are recommended.

3.4.5. Long Term Improvements

No long term improvements have been identified.

ACCIDENT DATA

SITE NUMBER 3

PERIOD FROM 1980 TO 1986

NUMBER OF ACCIDENTS BY YEAR

80	81	82	83	84	85	86
	1	2			1	

NUMBER OF ACCIDENTS BY DAY OF WEEK

SUN	MON	TUE	WED	THU	FRI	SAT
	1		1	1	1	

NUMBER OF ACCIDENTS BY MONTH

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	1									2	1

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

DRY	WET	SNOW	ICE	OTHER
2		1	1	

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

CLEAR	RAIN	SNOW	FOG	OVERCAST
3				1

NUMBER OF ACCIDENTS
BY LIGHT CONDITIONS

DAYLIGHT	DARK	DUSK	DAWN
2	2		

NUMBER OF ACCIDENTS BY SEVERITY

	80	81	82	83	84	85	86
INJURIES							
FATALITIES							
P. D. O.		1	2			1	

NUMBER OF ACCIDENTS
BY NUMBER OF INJURIES

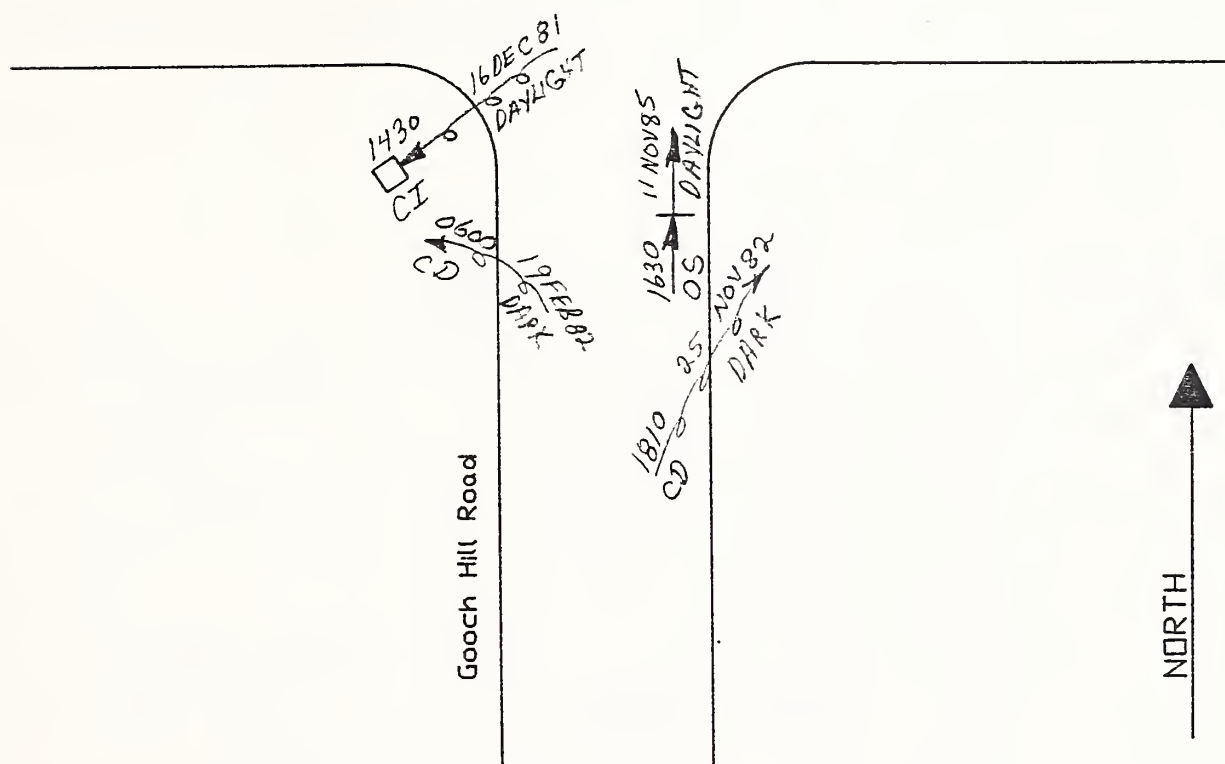
0	1	2	3	4	5
4					

NUMBER OF ACCIDENTS BY NO. OF FATALITIES

0	1	2	3	4	5
4					

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

ANGLE	LT - TURN	R - END	FX - OBJ	PED	ANIMAL	SDSWP	NON - COL	HD - ON
		1	1				2	



SYMBOLS

- ← VEHICLE PATH
- ← PEDESTRIAN PATH
- ↔ BACKING VEHICLE
- ⊠ PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION TYPE

- ←|← REAR END
- ←|← HEAD ON
- ←|↘ SIDESWIPE
- ←|○ OUT OF CONTROL
- ←| T RIGHT ANGLE
- ←|↘ LEFT TURN

CONDITIONS

TIME → 1500
R W
WEATHER →
PAVEMENT →

DATE → 08 AUG 85
DARK
LIGHT →

WEATHER:

R = RAIN, F = FOG,
C = CLEAR, S = SNOW

PAVEMENT:

D = DRY, W = WET, I = ICY

LOCATION: INTERSECTION US 191 AND GOOCH HILL ROAD, SEC 16 & 17, T2S, R5E

SITE 3

PERIOD: SEVEN YEARS

FROM: 1980

TO: 1986

PREPARED BY: PETERSON

DATE: AUGUST 1987

DETERMINATION OF HAZARD INDEX

Site No.: 3

Indicator	Data Value		Indicator Value	Weight	Partial H.I.
Number of Accidents	.6	acc/yr	18 X	.164 =	3.0
Accident Rate	.5	acc/mev	10 X	.225 =	2.3
Accident Severity	10.5	\$1000	64 X	.191 =	12.2
V/C Ratio	.57		100 X	.082 =	8.2
Sight Distance Ratio	2.00		0 X	.074 =	
Driver Expectancy	1.2	Rating	20 X	.149 =	3.0
Information System Deficiencies	.9	Rating	15 X	.115 =	1.7
Hazard Index (HI)					30

Benefit/Cost Indicator (BCI) 0

Priority Index = HI X 0.75 + BCI X 0.25 = 23

EXISTING
W2-1 (30" x 30")
H = 5'-4"

EXISTING
EMERGENCY
VEHICLES
ENTERING
600 FT
(30" x 30")
H = 3'-3"

FUTURE APPR.
BY M.D.O.H.

GOOCH HILL ROAD

US 191

EXISTING
STOP
R1-1 (30")
H = 5'-11"

4" DBL. YELLOW (TYP)

EXISTING
STOP
AHEAD
W3-1 (30" x 30")
H = 5'-9"

STOP
R1-1 (30")
EXISTING
H = 5'-4"



SITE NO. 3

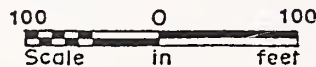
EXISTING CONDITIONS AND SHORT TERM IMPROVEMENTS



Prepared By
Morrison-Maierle, Inc.
Consulting Engineers

Prepared For
Gallatin County
Road Office, 1987

EXISTING
W2-1 (30" x 30")
H = 6'-9"



3.5. SITE 4

3.5.1. Location

This site includes the intersection of Bozeman Trail and the frontage road just northeast of I-90 at the Bear Creek Interchange (locally referred to as the East Frontage Road) in Section 23, Township 2 South, Range 6 East. County personnel have indicated that this site falls under the jurisdiction and maintenance of the Montana Department of Highways.

3.5.2. Existing Conditions

The intersection includes thru movements between the north and west legs and stop conditions at the north and east legs, where the large majority of traffic volumes occur. The south leg dead-ends at a trucking company warehouse a short distance south of the intersection. All approaches, except the east leg (Bozeman Trail extension), are asphalt paved.

Traffic volumes (ADT) are estimated as follows, based on 24 hour machine counts performed in August 1987:

East Leg	300
South Leg	40
West Leg	1030
North Leg	1320

Grades are uniform and flat and sight distance is greater than twice the recommended safe stopping sight distance.

Numerous regulatory, guide and warning signs exist and are shown on the included site sketch. The Large Arrow Sign (W1-8), shown on the site sketch as removed, was run over by an out-of-control vehicle in September 1987. In the southwest quadrant of the intersection, near the removed Large Arrow Sign, is the outlet of a culvert and related ditch.

Using guidelines included on page 166 of the AASHTO "Green Book", it was determined using a ball-bank indicator that safe speeds on the curve are less than 15 mph for either direction of travel.

3.5.3. Accident History and Analysis

Five accidents were recorded at the site during the seven year period and all five involved vehicles approaching the intersection from the west and failing to negotiate the right turn to the south on Bozeman Trail. All but one were on dry roadways. Three of the 5 were after dark. Three of the 5 included injuries in addition to property damage.

3.5.4. Short Term Improvements

Eliminating the thru movements between the north and west legs should be considered. As indicated above, the existing curve has a safe speed of less than 15 mph. Drivers approaching the curve from the north may see the dead end road to the south and, if

they are not attentive, may not realize until the last second that they need to turn. The very sharp curve would then be very difficult to negotiate, as reflected in the accident records.

A 48" X 48" Stop Sign (R1-1) with an Advance Stop Warning Sign (W3-14) should be installed on the north approach.

If the above Stop Sign is installed, the existing Turn Sign (W1-1) on the north leg and the Stop Sign (R1-1) on the east leg should be removed.

3.5.5. Long Term Improvements

Long term improvements should include extending the existing culvert in the southwest quadrant, flattening side slopes and thereby improving the recovery area and reducing the severity of accidents.

ACCIDENT DATA

SITE NUMBER 4

PERIOD FROM 1980 TO 1986

NUMBER OF ACCIDENTS BY YEAR

80	81	82	83	84	85	86
	1	1			1	2

NUMBER OF ACCIDENTS BY DAY OF WEEK

SUN	MON	TUE	WED	THU	FRI	SAT
1				2	1	1

NUMBER OF ACCIDENTS BY MONTH

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
			1			1	1		1	1	

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

DRY	WET	SNOW	ICE	OTHER
4	1			

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

CLEAR	RAIN	SNOW	FOG	OVERCAST
4	1			

NUMBER OF ACCIDENTS
BY LIGHT CONDITIONS

DAYLIGHT	DARK	DUSK	DAWN
2	3		

NUMBER OF ACCIDENTS BY SEVERITY

	80	81	82	83	84	85	86
INJURIES			1			1	1
FATALITIES							
P. D. O.		1					1

NUMBER OF ACCIDENTS
BY NUMBER OF INJURIES

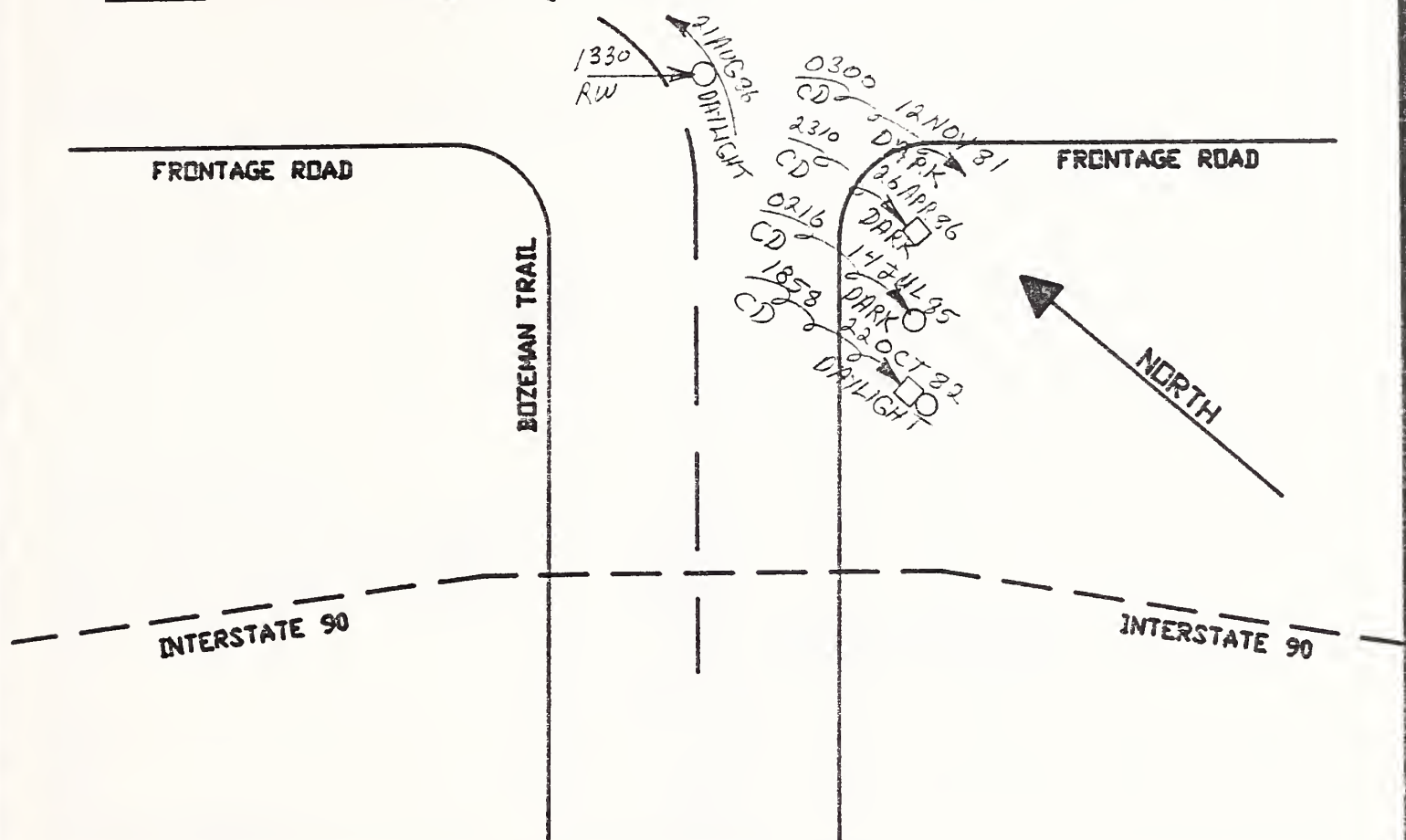
0	1	2	3	4	5
2	1	2			

NUMBER OF ACCIDENTS BY NO. OF FATALITIES

0	1	2	3	4	5
5					

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

ANGLE	LT - TURN	R - END	FX - OBJ	PED	ANIMAL	SDSWP	NON - COL	HD - ON
			2			1	2	



SYMBOLS

- ← VEHICLE PATH
- ← PEDESTRIAN PATH
- ↔ BACKING VEHICLE
- ▣ PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION TYPE

- ↔ REAR END
- ↔ HEAD ON
- ↔ SIDESWIPE
- ↔ OUT OF CONTROL
- ↔ RIGHT ANGLE
- ↔ LEFT TURN

CONDITIONS

TIME: 1500
 DATE: 08 AUG 85
 WEATHER: R (RAIN)
 PAVEMENT: V (WET)
 LIGHT: DARK

WEATHER:

R = RAIN, F = FOG,
 C = CLEAR, S = SNOW

PAVEMENT:

D = DRY, W = WET, I = ICY

LOCATION: BOZEMAN TRAIL NEAR I-90 INTERCHANGE, SEC23, T2S, R6E

SITE 4

PERIOD: SEVEN YEARS

FROM: 1980

TO: 1986

PREPARED BY: PETERSON

DATE: AUGUST 1987

DETERMINATION OF BENEFITS AND COSTS

SITE _____ 4

Estimated 5 Year Service Life
Interest Rate = 10%

1987 ADT 1315
7 Years Accident Data

ANNUAL COST

Capital Cost =	340
K=0.264	.264
M = 0	0
Annual Cost =	90

ANNUAL BENEFIT

1992 ADT (7% FOR 5 YEARS)	1844
COST PER FATAL ACCIDENT	240000
COST PER INJURY ACCIDENT	10800
COST OF PD ACC	1600
I/F	19
Q	22300
Afi	.4
Apd	.3
Pfi	.47
Ppd	.47
ANNUAL BENEFIT	6197

SECONDARY ROADS

B/C	69.0
-----	------

INDICATOR VALUE	92
-----------------	----

DETERMINATION OF HAZARD INDEX

Site No.: 4

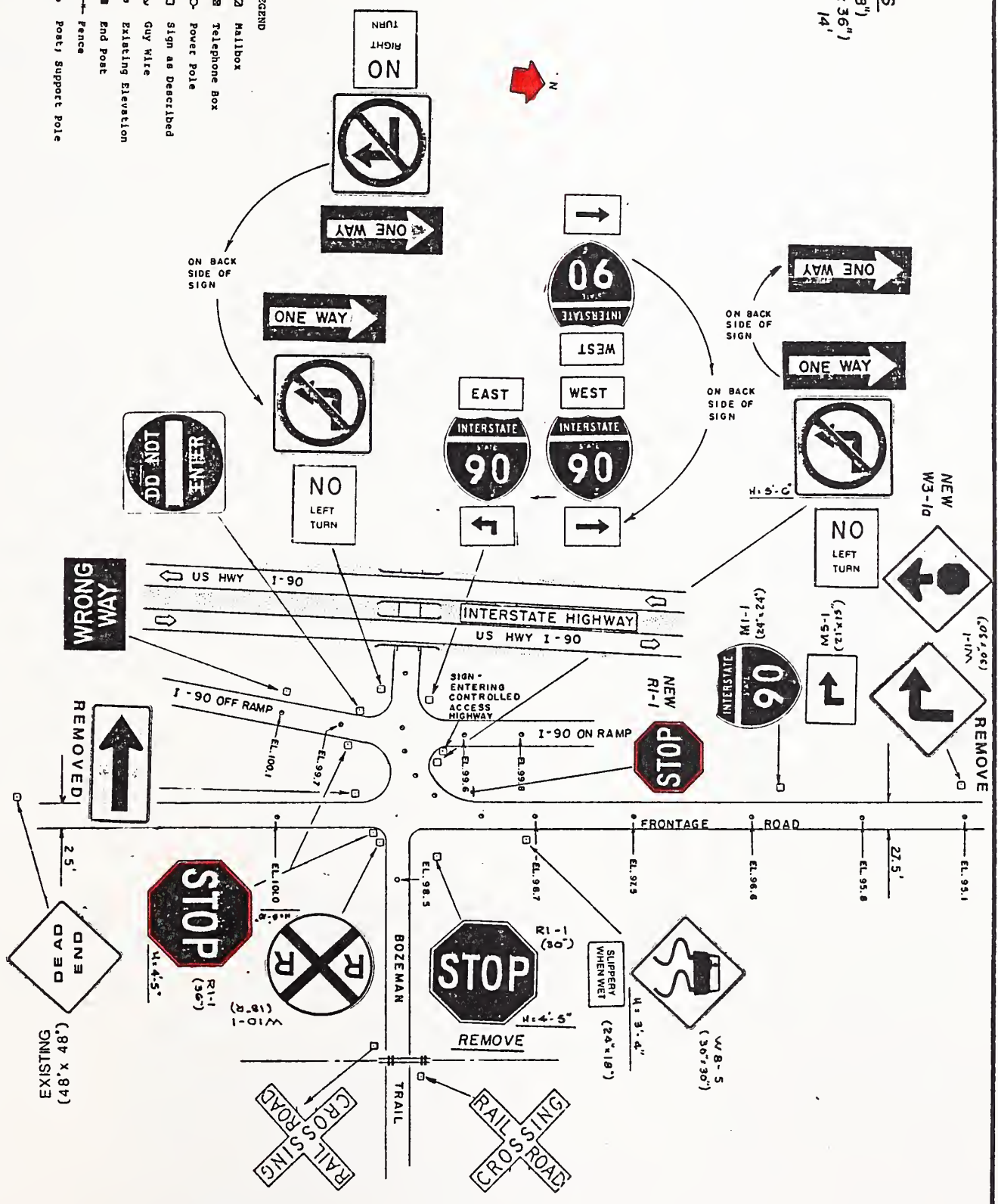
Indicator	Data Value		Indicator Value	Weight	Partial H.I.
Number of Accidents	.7	acc/yr	20 X	.164 =	3.3
Accident Rate	1.5	acc/mev	26 X	.225 =	5.9
Accident Severity	12.7	\$1000	70 X	.191 =	13.4
V/C Ratio	.22		39 X	.082 =	3.2
Sight Distance Ratio	2.00		0 X	.074 =	
Driver Expectancy	3.9	Rating	65 X	.149 =	9.7
Information System Deficiencies	1.5	Rating	25 X	.115 =	2.9
Hazard Index (HI)					----- 38

Benefit/Cost Indicator (BCI) 92

Priority Index = HI X 0.75 + BCI X 0.25 = 52

QUANTITIES
 1 - R1-1 (48" x 48")
 1 - W3-10 (36" x 36")
 1 - 4" Ø POLE @ 14'

- LEGEND**
- Mailbox
 - Telephone Box
 - Power Pole
 - Sign as Described
 - ✓ Guy Wire
 - Existing Elevation
 - End Post
 - Fence
 - Post/Support Pole



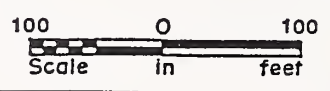
SITE NO. 4

EXISTING CONDITIONS AND SHORT TERM IMPROVEMENTS



Prepared By
 Morrison-Maierle, Inc.
 Consulting Engineers

Prepared For
 Gallatin County
 Road Office, 1987



Bill
 7604

3.6. SITE 5

3.6.1. Location

This site is the "T" intersection of Durston Road and Ferguson Road in Section 10, Township 2 South, Range 5 East.

3.6.2. Existing Conditions

Both Durston and Ferguson Roads are gravel surfaced. There are no existing signs or other traffic control devices. Roadway widths range from 22 feet to 24 feet, as shown on the site sketch, with no shoulders. Traffic (ADT) on Durston Road west of the intersection is estimated at 240 vehicles per day based on 24 hour machine counts conducted in August 1987. Traffic is estimated at 87 vehicles per day on Ferguson Road based on machine counts conducted by Gallatin County. No counts are available for Durston road east of the intersection. It should be noted that, according to county road personnel, the east half of Ferguson Road is owned by the city and maintained by the county.

3.6.3. Accident History and Analysis

Four accidents were recorded at the intersection during the 7-year period. Two involved vehicles unable to properly stop at the intersection as they approached from the south. A third involved a head-on with two turning vehicles and the fourth involved an out-of-control vehicle traveling west on Durston.

3.6.4. Short Term Improvements

A new T Symbol Sign (W2-4) is recommended to be placed on Ferguson Road at the location shown on the site sketch. Side Road Signs (W2-4) on Durston Road east and west of the intersection are recommended. A bi-directional Large Arrow Sign (W1-7) is also recommended at the location shown.

The characteristics of the few accidents which have occurred do not indicate a need for a stop sign--all but one were single vehicle accidents. None of the other warrants for a stop sign are present.

3.6.5. Long Term Improvements

Long term improvements should include the relocation of the power pole located near the north edge of the Durston Road at the intersection.

ACCIDENT DATA

SITE NUMBER 5

PERIOD FROM 1980 TO 1986

NUMBER OF ACCIDENTS BY YEAR

80	81	82	83	84	85	86
	1		1		1	1

NUMBER OF ACCIDENTS BY DAY OF WEEK

SUN	MON	TUE	WED	THU	FRI	SAT
1	1			1	1	

NUMBER OF ACCIDENTS BY MONTH

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1		2									1

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

DRY	WET	SNOW	ICE	OTHER
2			2	

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

CLEAR	RAIN	SNOW	FOG	OVERCAST
4				

NUMBER OF ACCIDENTS
BY LIGHT CONDITIONS

DAYLIGHT	DARK	DUSK	DAWN
2	2		

NUMBER OF ACCIDENTS BY SEVERITY

	80	81	82	83	84	85	86
INJURIES				1			1
FATALITIES							
P. D. O.		1				1	

NUMBER OF ACCIDENTS
BY NUMBER OF INJURIES

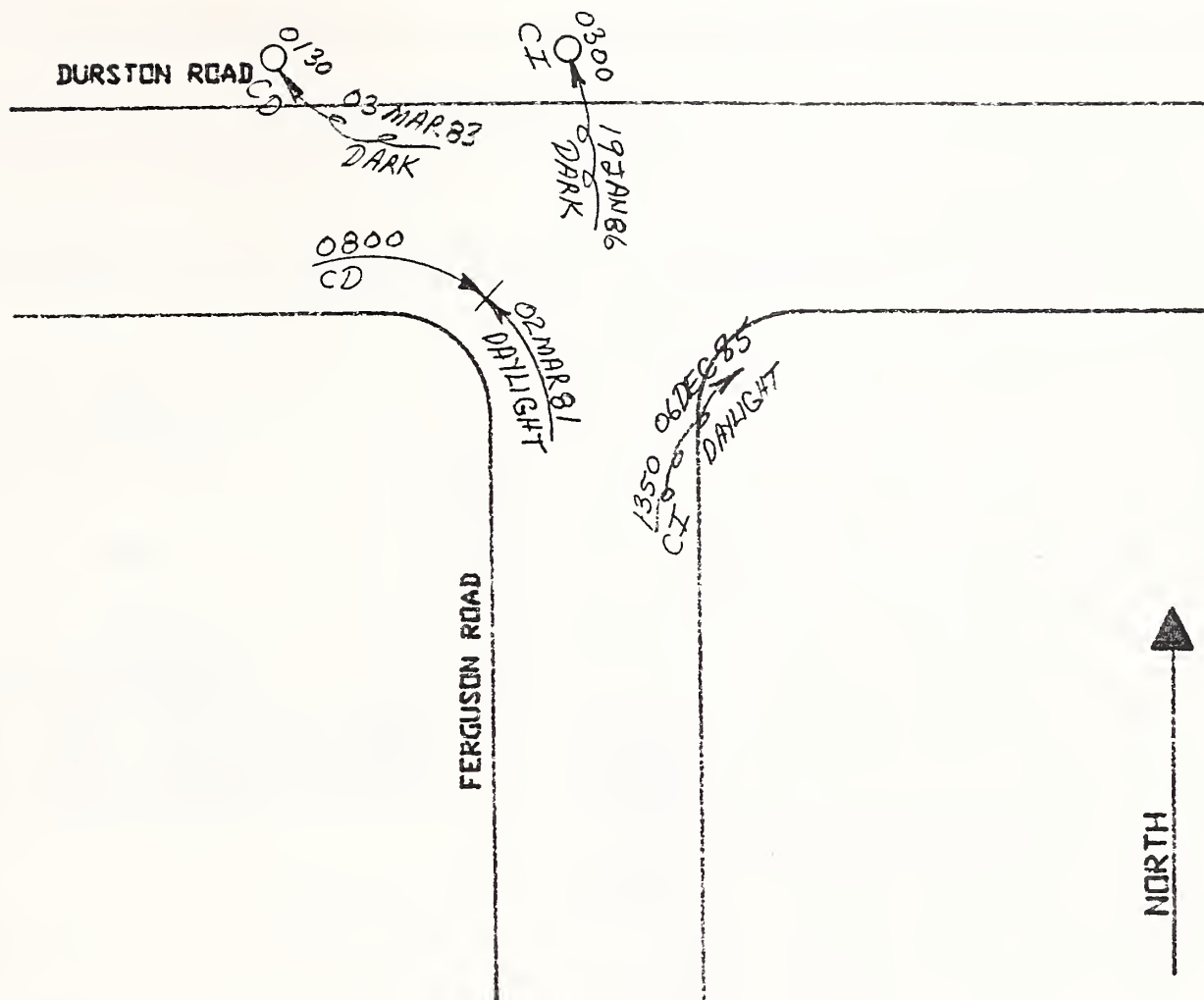
0	1	2	3	4	5
4					

NUMBER OF ACCIDENTS BY NO. OF FATALITIES

0	1	2	3	4	5
4					

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

ANGLE	LT - TURN	R - END	FX - OBJ	PED	ANIMAL	SDSWP	NON - COL	HD - ON
							3	1



SYMBOLS

- ← VEHICLE PATH
- ← PEDESTRIAN PATH
- ↔ BACKING VEHICLE
- ☒ PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION TYPE

- ↔ REAR END
- ↔ HEAD ON
- ↔ SIDESWIPE
- ↔ OUT OF CONTROL
- ↔ RIGHT ANGLE
- ↔ LEFT TURN

CONDITIONS

TIME → 1500 → DATE → 08 AUG 85
 ← R W ← DARK ←
 WEATHER ← LIGHT
 PAVEMENT ←

WEATHER:

R = RAIN, F = FOG,
 C = CLEAR, S = SNOW

PAVEMENT:

D = DRY, W = WET, I = ICY

LOCATION: INTERSECTION FERGUSON ROAD/DURSTON ROAD, SEC 10, T2S, R5E

SITE 5

PERIOD: SEVEN YEARS

FROM: 1980

TO: 1986

PREPARED BY: PETERSON

DATE: AUGUST 1987

DETERMINATION OF BENEFITS AND COSTS

SITE _____ 5

Estimated 5 Year Service Life
Interest Rate = 10%

1987 ADT 365
7 Years Accident Data

ANNUAL COST

Capital Cost =	600
K=0.264	.264
M = 0	0
Annual Cost =	158

ANNUAL BENEFIT

1992 ADT (7% FOR 5 YEARS)	512
COST PER FATAL ACCIDENT	240000
COST PER INJURY ACCIDENT	10800
COST OF PD ACC	1600
I/F	19
Q	22300
Afi	.3
Apd	.3
Pfi	.51
Ppd	.51
ANNUAL BENEFIT	5129

SECONDARY ROADS

B/C	32.4
INDICATOR VALUE	76

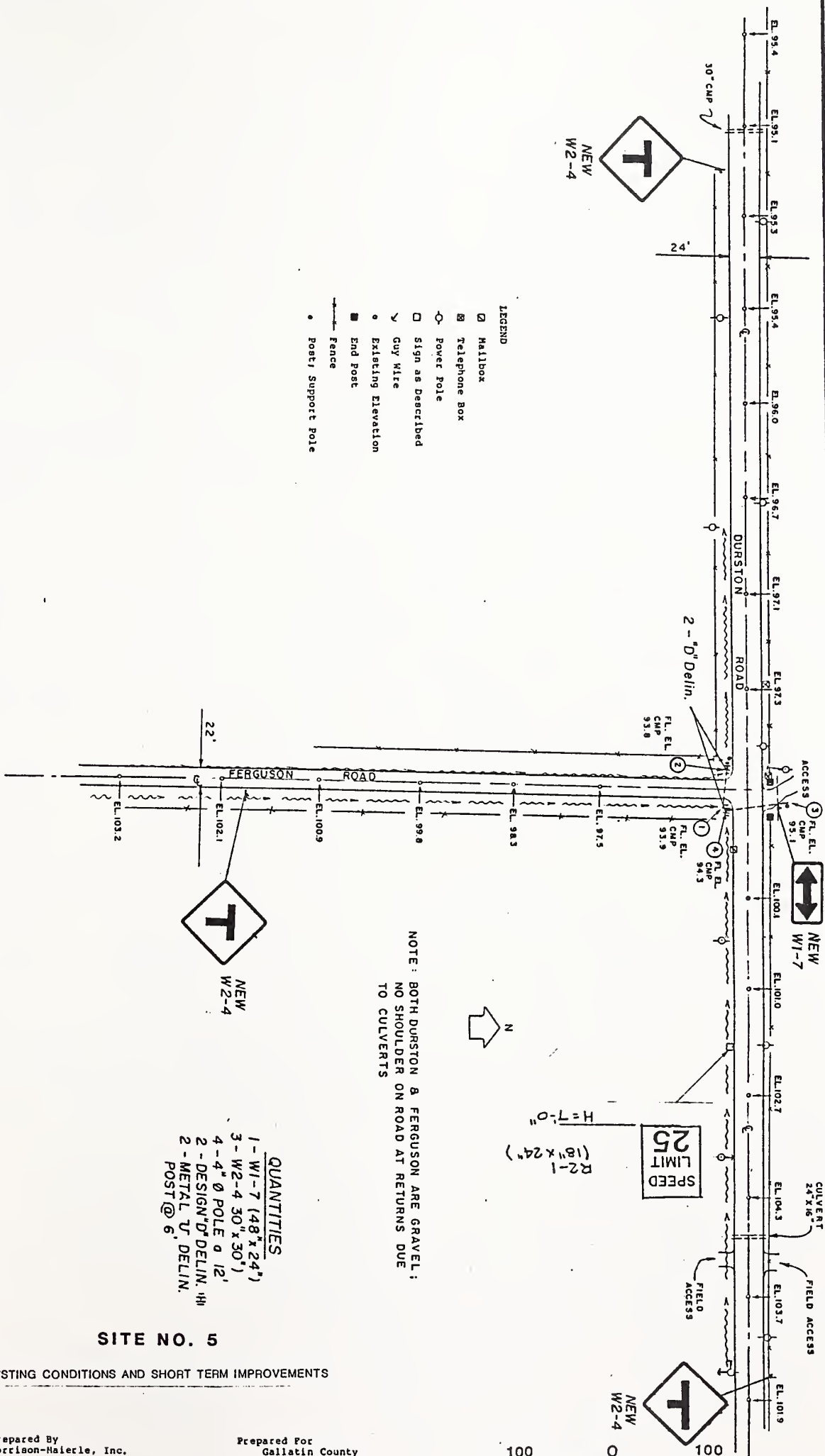
DETERMINATION OF HAZARD INDEX

Site No.: 5

Indicator	Data Value		Indicator Value	Weight	Partial H.I.
-----	-----		-----	-----	-----
Number of Accidents	.6	acc/yr	18 X	.164 =	3.0
Accident Rate	4.3	acc/mev	60 X	.225 =	13.5
Accident Severity	12.8	\$1000	71 X	.191 =	13.6
V/C Ratio	.05		17 X	.082 =	1.4
Sight Distance Ratio	2.00		0 X	.074 =	
Driver Expectancy	3.3	Rating	55 X	.149 =	8.2
Information System Deficiencies	3.8	Rating	63 X	.115 =	7.3
Hazard Index (HI)					----- 47

Benefit/Cost Indicator (BCI) 76

Priority Index = HI X 0.75 + BCI X 0.25 = 54



3.7. SITE 6

3.7.1. Location

Site 6 is located at the intersection of Valley Center Drive and the Burlington Northern Railroad tracks in Section 22, Township 1 South, Range 5 East. The site lies between the old US Highway 10 and I-90.

3.7.2. Existing Conditions

Valley Center Drive, at Site 6, has recently been paved and is approximately 24 feet wide. Vertical alignment is uniform and relatively flat--including over the railroad tracks. The railroad crossing lies 105 feet from the centerline of US 10 and 350 feet from the intersection of Valley Center Drive and Davis Road. Railroad Crossing (Crossbuck) Signs (R15-1) are located on the right side of each approach just preceding the tracks. Back to back Flashing Light Signals are mounted on the same posts and are visible, therefore, on both sides of the road from both approaches. Railroad Advance Warning Signs are located at the following locations, as shown on the site sketch:

1. 48 feet north of the tracks
2. 280 feet south of the tracks, and
3. 425 feet south of the tracks and 145 feet south of Davis Road.

Sign 2 above is in poor condition with several bullet holes.

Traffic on Valley Center is controlled at US 10 by a Stop Sign (R1-1). Side Road Signs (W2-2) are in place on US 10 in advance of Valley Center Drive from both directions.

Traffic on Valley Center Drive is estimated at 2800 vehicles per day based on 24 hour machine counts performed in August 1987. MDOH counts in 1985 and 1987 have indicated only 1300 +/- vpd.

A project is currently being designed which will include a connecting street from the Davis Road/Valley Center Drive intersection west along the interstate to Bozeman. Traffic volumes will therefore change significantly. MDOH projections indicate volumes on Valley Center Drive and Davis Road will more than double after the new connection is constructed (1990). Based on those projections, the future ADT at the railroad crossing is estimated at 2600 vpd.

Trains cross Valley Center Drive normally 15 times per day at a speed of approximately 60 mph.

Using guidelines included on page 166 of the AASHTO "Green Book", it was determined using a ball-bank indicator that safe speeds on the curve southwest of Davis Road are approximately 30 mph for either direction of travel.

3.7.3. Accident History and Analysis

One accident record was available at Site 6 for the 7 year period. It involved a car which entered Valley Center Drive at Davis Road, proceeded northerly and hit the side of the second unit of a westbound train. A contributing factor is that the road was snow covered and slick. The driver indicated he did not see the train.

Though only one accident record was found involving a car/train accident, county and state officials have indicated that they remember one more similar accident that happened near the same time.

3.7.4. Short Term Improvements

Railroad Advance Warning Signs (W10-3) are recommended to replace the existing Side Road Signs on US 10. The Railroad Advance Warning Sign (W10-1) damaged by bullet holes should also be replaced.

Since safe speeds on the curve on Valley Center Drive South of the railroad crossing are approximately 30 mph, it is recommended that the Curve Sign (W1-2) and the 25 mph Advisory Speed Plate (W13-1) be replaced with a Turn Sign (W1-1) and a 30 mph Advisory Speed Plate (W13-1).

3.7.5. Long Term Improvements

During the summer of 1987 the area of the site triangle for traffic approaching the tracks on Valley Center Drive from the South was cleared, excavated and leveled. Drivers are now able, should they ignore or fail to note warning signs and signals, to see approaching trains somewhat sooner than before. It is recommended that this area, as indicated on the site sketch be cleaned, cleared and/or mowed on a frequent and regular basis to assure that sight from the roadway to approaching trains is never obstructed. Consideration should be given to excavating the area even further since, under current conditions, only a small amount of grass or weed growth or a foot or more of snow would affect sight conditions.

Automatic gates should be considered in the future. They will help compensate for the limited sight distance on the south approach caused by the interstate crossing. Using guidelines in the report Safety Engineering Improvement Program, MDOH, it can be shown that, using current estimated ADT of 1300 vpd, the hazard index (H.I.) for the railroad crossing is approximately 1170. Using the projected future ADT of 2600 vpd, the hazard index is approximately 2340. Section IV of the above mentioned report indicates that, for a rural crossing, gates should be considered for an H.I. over 1000.

ACCIDENT DATA

SITE NUMBER 6

PERIOD FROM 1980 TO 1986

NUMBER OF ACCIDENTS BY YEAR

80	81	82	83	84	85	86
					1 *	

NUMBER OF ACCIDENTS BY DAY OF WEEK

SUN	MON	TUE	WED	THU	FRI	SAT
	1 *					

NUMBER OF ACCIDENTS BY MONTH

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
										1 *	

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

DRY	WET	SNOW	ICE	OTHER
		1 *		

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

CLEAR	RAIN	SNOW	FOG	OVERCAST
				1 *

NUMBER OF ACCIDENTS BY LIGHT CONDITIONS

DAYLIGHT	DARK	DUSK	DAWN
1 *			

NUMBER OF ACCIDENTS BY SEVERITY

	80	81	82	83	84	85	86
INJURIES						2	
FATALITIES							
P. D. O.							

NUMBER OF ACCIDENTS BY NUMBER OF INJURIES

0	1	2	3	4	5
				1 *	

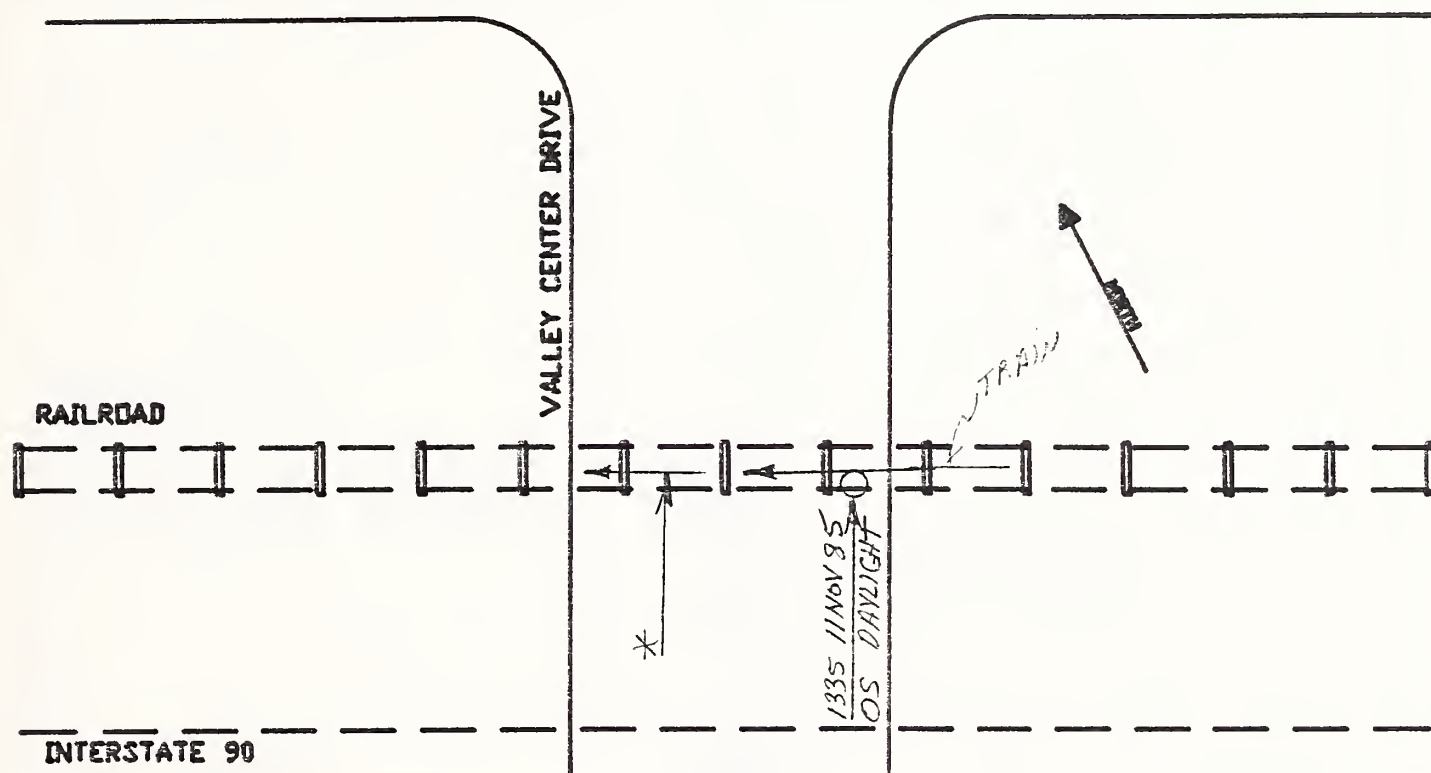
NUMBER OF ACCIDENTS BY NO. OF FATALITIES

0	1	2	3	4	5
2					

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

ANGLE	LT - TURN	R - END	FX - OBJ	PED	ANIMAL	SDSWP	NON - COL	HD - ON
						2 TRAIN		

* DATA FOR 2ND. ACCIDENT NOT AVAILABLE.



SYMBOLS

- ← VEHICLE PATH
- ← PEDESTRIAN PATH
- ↔ BACKING VEHICLE
- ☒ PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION TYPE

- ←+← REAR END
- ←+← HEAD ON
- ←+↘ SIDESWIPE
- ←+○ OUT OF CONTROL
- ←+⊥ RIGHT ANGLE
- ←+↘ LEFT TURN

* No records available.
However, several local people
have indicated a 2nd
similar accident did occur
in about the same year,
1985.

CONDITIONS

TIME → 1500
DATE → 08 AUG 85
WEATHER → DARK
PAVEMENT →

WEATHER:

R = RAIN, F = FOG,
C = CLEAR, S = SNOW

PAVEMENT:

D = DRY, V = WET, I = ICY

LOCATION: VALLEY CENTER DRIVE, RAILROAD, US 10, SEC 22, T1S, R5E

SITE 6

PERIOD: SEVEN YEARS

FROM: 1980

TO: 1986

PREPARED BY: PETERSON

DATE: AUGUST 1987

DETERMINATION OF BENEFITS AND COSTS

SITE _____ 6

Estimated 5 Year Service Life
Interest Rate = 10%

1987 ADT 1300
7 Years Accident Data

ANNUAL COST

Capital Cost =	560
K=0.264	.264
M = 0	0
Annual Cost =	148

ANNUAL BENEFIT

1992 ADT	2600
COST PER FATAL ACCIDENT	240000
COST PER INJURY ACCIDENT	10800
COST OF PD ACC	1600
I/F	19
Q	22300
Afi	.3
Apd	.0
Pfi	.52
Ppd	.52
ANNUAL BENEFIT	6958

SECONDARY ROADS

B/C	47.1
-----	------

INDICATOR VALUE	84
-----------------	----

DETERMINATION OF HAZARD INDEX

Site No.: 6

Indicator	Data Value		Indicator Value	Weight	Partial H.I.
-----	-----		-----	-----	-----
Number of Accidents	.3	acc/yr	10 X	.164 =	1.6
Accident Rate	.3	acc/mev	7 X	.225 =	1.6
Accident Severity	39.1	\$1000	100 X	.191 =	19.1
V/C Ratio	.55		100 X	.082 =	8.2
Sight Distance Ratio	.28		100 X	.074 =	7.4
Driver Expectancy	3.4	Rating	57 X	.149 =	8.4
Information System Deficiencies	3.3	Rating	55 X	.115 =	6.3

Hazard Index (HI)					53

Benefit/Cost Indicator (BCI) 84

Priority Index = HI X 0.75 + BCI X 0.25 = 61

3.8. SITE 7

3.8.1. Location

Site 7 includes a section on Sypes Canyon Road from 1.6 miles northeast of Springhill Road (Secondary 411) to 1.9 miles northeast. The site is in Section 18, Township 1 South, Range 6 East.

3.8.2. Existing Conditions

Sypes Canyon Road in this area is generally 18 feet wide with no shoulders and is gravel surfaced. Toward the end of the grading cycle, the surface tends to become corrugated. The roadway travels through rolling terrain with gentle slopes and curves. The sharpest horizontal curve includes a 250 foot radius (a degree of curvature of about 23 degrees). Vertical grades in the area range to 5%. No signing or other traffic control devices exist in the site area. ADT on Sypes Canyon Road, based on 24 hour machine counts performed in August 1987, is estimated to be 460 vehicles per day.

The curve at Station 20+00 has a sight distance of only 320 feet from either direction. At least one of the accidents occurred on this curve.

Using guidelines included on page 166 of the AASHTO "Green Book", it was determined using a ball-bank indicator that the safe speed on the curve near Station 10+00 is approximately 35 mph. The safe speed on all other curves in the area are greater than 35 mph.

3.8.3. Accident History and Analysis

In Section 18, 8 accidents were recorded during the 7 year period from 1980 to 1986. Five of the accidents were scattered throughout the section and three were identifiable as occurring within the 0.3 mile section defined as Site 7. Two of the three were after dark. The third occurred at 7:50 a.m. in mid December so, though the accident report indicated daylight, there is a possibility that light conditions were not ideal. All three accidents involved out-of-control westbound vehicles.

3.8.4. Short Term Improvements

It is recommended that Design "F" Flexible Delineators be installed as shown on the site sketch to help make curves more visible to vehicles after dark.

Curve Signs (W1-2) and other warning signs were considered but are not recommended. This site is part of a section of road several miles long with, as mentioned above, numerous grade changes and horizontal curves. The entire roadway is narrow, gravel and at times corrugated--drivers adjust to the character of the roadway and the curves on Site 7 are therefore not unexpected. Ball-bank readings, as indicated above, confirm this.

3.8.5. Long Term Improvements

No long term improvements have been identified at this site. As traffic continues to increase on Sypes Canyon Road, general improvement and/or reconstruction of the entire roadway may be considered.

ACCIDENT DATA

SITE NUMBER 7

PERIOD FROM 1980 TO 1986

NUMBER OF ACCIDENTS BY YEAR

80	81	82	83	84	85	86
			1		2	

NUMBER OF ACCIDENTS BY DAY OF WEEK

SUN	MON	TUE	WED	THU	FRI	SAT
	1	1				1

NUMBER OF ACCIDENTS BY MONTH

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
			2								1

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

DRY	WET	SNOW	ICE	OTHER
1	1		1	

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

CLEAR	RAIN	SNOW	FOG	OVERCAST
1				2

NUMBER OF ACCIDENTS
BY LIGHT CONDITIONS

DAYLIGHT	DARK	DUSK	DAWN
1	2		

NUMBER OF ACCIDENTS BY SEVERITY

	80	81	82	83	84	85	86
INJURIES				1		2	
FATALITIES							
P. D. O.							

NUMBER OF ACCIDENTS
BY NUMBER OF INJURIES

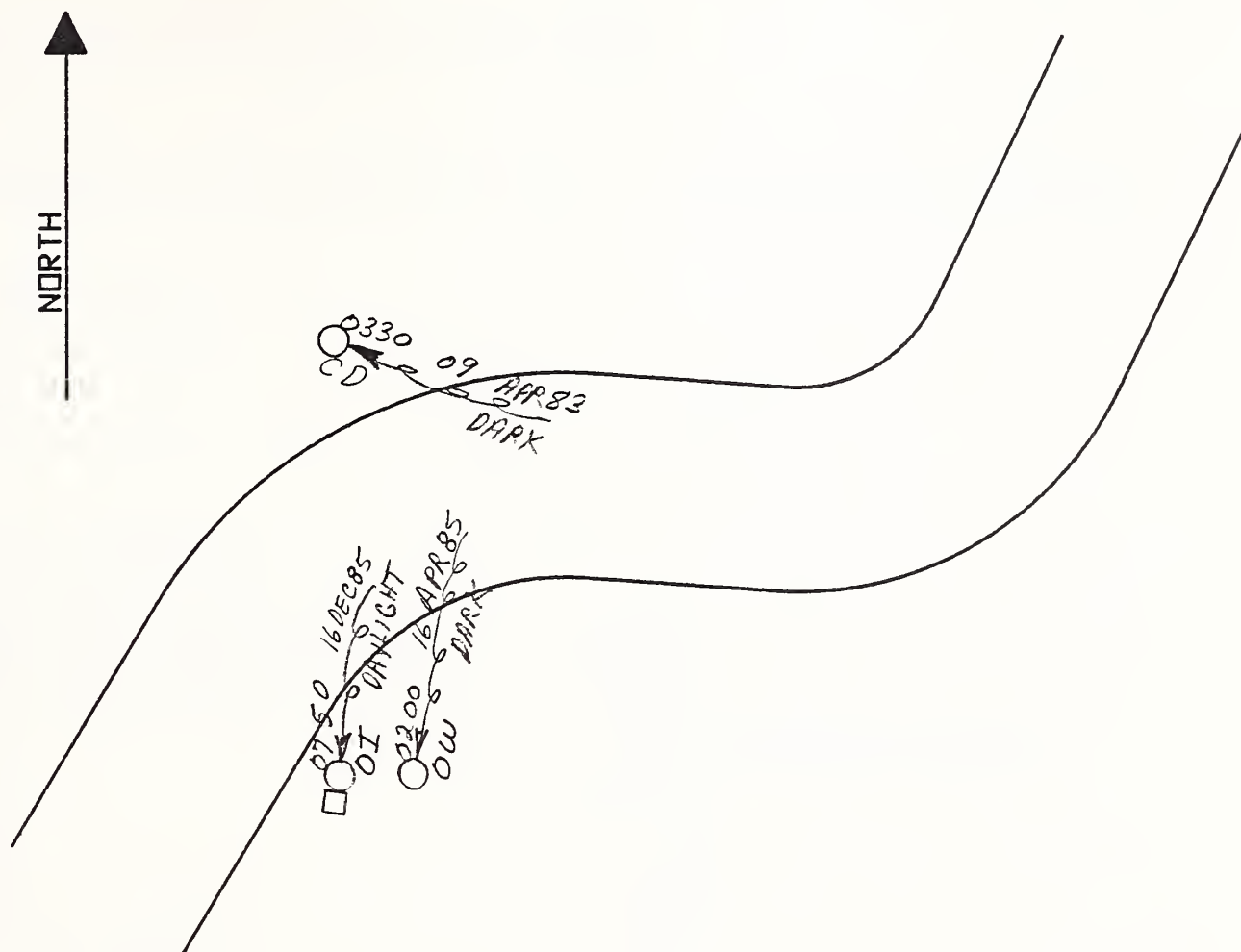
0	1	2	3	4	5
	2	1			

NUMBER OF ACCIDENTS BY NO. OF FATALITIES

0	1	2	3	4	5
3					

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

ANGLE	LT - TURN	R - END	FX - OBJ	PED	ANIMAL	SDSWP	NON - COL	HD - ON
			1				2	



SYMBOLS

- ← VEHICLE PATH
- ← PEDESTRIAN PATH
- ↔ BACKING VEHICLE
- ▣ PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION TYPE

- ↔ REAR END
- ↔ HEAD ON
- ↔ SIDESWIPE
- ↔ OUT OF CONTROL
- ↔ RIGHT ANGLE
- ↔ LEFT TURN

CONDITIONS

TIME → 1500 ← DATE → 08 AUG 85
 ← R W ← DARK ←
 WEATHER →
 PAVEMENT → LIGHT

WEATHER:

R = RAIN, F = FOG,
 C = CLEAR, S = SNOW

PAVEMENT:

D = DRY, W = WET, I = ICY

LOCATION: SYPES CANYON ROAD, SEC 18, T1S, R6E

PERIOD: SEVEN YEARS

FROM: 1980

TO: 1986

PREPARED BY: PETERSON

DATE: AUGUST 1987

SITE 7

DETERMINATION OF BENEFITS AND COSTS

SITE _____ 7

Estimated 5 Year Service Life
Interest Rate = 10%

1987 ADT 456
7 Years Accident Data

ANNUAL COST

Capital Cost =	340
K=0.264	.264
M = 0	0
Annual Cost =	90

ANNUAL BENEFIT

1992 ADT (7% FOR 5 YEARS)	640
COST PER FATAL ACCIDENT	240000
COST PER INJURY ACCIDENT	10800
COST OF PD ACC	1600
I/F	19
Q	22300
Afi	.3
Apd	.0
Pfi	.19
Ppd	.19
ANNUAL BENEFIT	1783

SECONDARY ROADS

B/C	19.9
-----	------

INDICATOR VALUE	65
-----------------	----

DETERMINATION OF HAZARD INDEX

Site No.: 7

Indicator	Data Value		Indicator Value	Weight	Partial H.I.
Number of Accidents	.4	acc/yr	13 X	.164 =	2.1
Accident Rate	2.6	acc/mev	42 X	.225 =	9.5
Accident Severity	12.4	\$1000	70 X	.191 =	13.4
V/C Ratio	.16		33 X	.082 =	2.7
Sight Distance Ratio	.91		42 X	.074 =	3.1
Driver Expectancy	3.0	Rating	50 X	.149 =	7.5
Information System Deficiencies	2.9	Rating	48 X	.115 =	5.6
Hazard Index (HI)					44

Benefit/Cost Indicator (BCI) 65

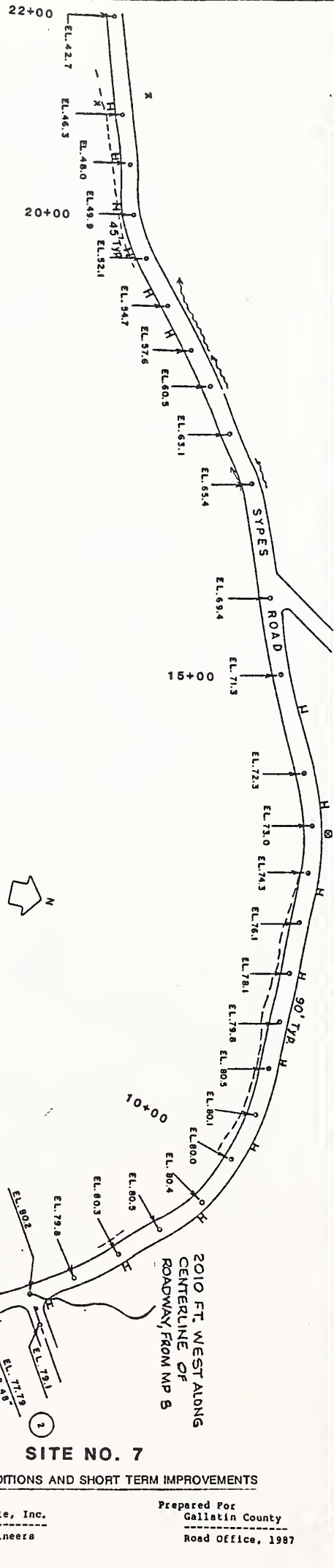
Priority Index = HI X 0.75 + BCI X 0.25 = 49

- LEGEND
- Mailbox
 - ⊠ Telephone Box
 - Power Pole
 - Sign as Described
 - ∨ Guy Wire
 - Existing Elevation
 - End Post
 - Fence
 - Post/ Support Pole

NOTE: SYPPES ROAD IS NARROW (18'-20')
WITH SOUTHSIDE OF ROAD SHOULDER
VERY STEEP; NO SIGNS; SPEED
PROBLEM WITH GRAVEL, WASHBOARD
ROAD

17 - DESIGN "F" FLEXIBLE DELIN.
POSTS H (See Spec. Prov.)

QUANTITIES



SITE NO. 7

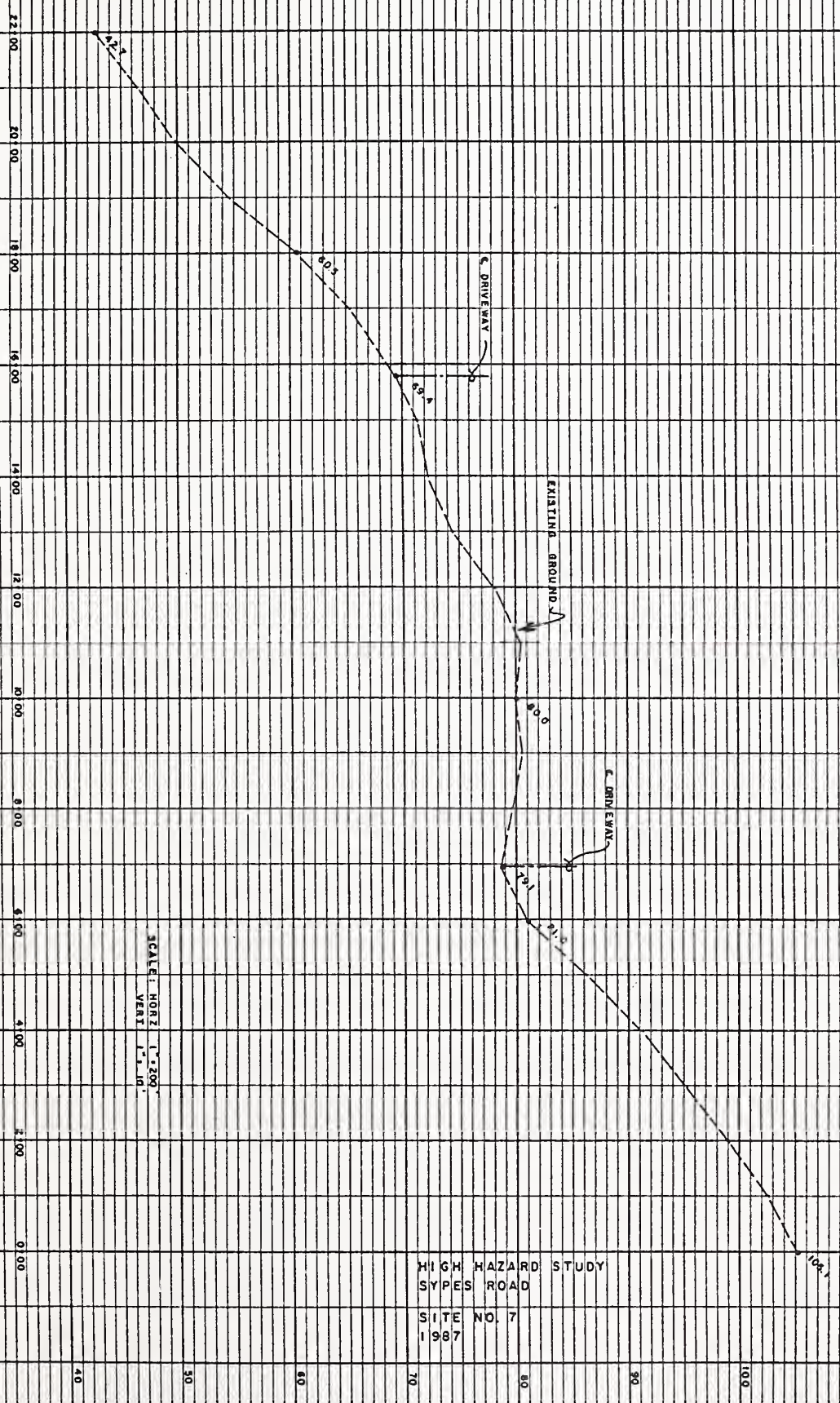
EXISTING CONDITIONS AND SHORT TERM IMPROVEMENTS

Prepared By
Morrison-Maierle, Inc.
Consulting Engineers

Prepared For
Gallatin County
Road Office, 1987



Scale 0 100 200 feet



HIGH HAZARD STUDY
SYDES ROAD
SITE NO. 7
1987

3.9. SITE 8

3.9.1. Location

This site includes several curves on the Jackson Creek Road in Section 34, Township 1 South, Range 7 East. Since the recorded accidents occurred on the curve at Station 5+00, following discussion concentrates in this area.

3.9.2. Existing Conditions

The roadway is narrow, gravel surfaced with no shoulders and a general width of approximately 18 feet. The roadway is used for access to summer homes and as a cut-off between Interstate 90 and the road to Bridger Bowl Ski Area. As mentioned above, the curve where the accident cluster has been recorded is sharp with very poor sight distance around the curve because of a steep bank on the inside of the curve. ADT is estimated to be 170 vehicles per day based 24 hour machine counts conducted in August 1987.

Current signing includes a Reverse Turn Sign (W1-3) with a 15 mph Advisory Speed Plate W13-1) south of the curve and a similar sign combination north of the next curve east.

Using guidelines included on page 166 of the AASHTO "Green Book", it was determined using a ball-bank indicator that safe speeds on the curve at Station 5+00 and the curve to the east are approximately 15 mph from either direction of travel.

3.9.3. Accident History and Analysis

Five accidents have been recorded during the period 1980 to 1986. Three were head-ons which have a high severity ranking. One of the head-ons included injuries. The other two involved vehicles traveling north, downhill and out-of-control. Three of the 5 were after dark and 3 of the 5 were on icy or snow covered roads.

3.9.4. Short Term Improvements

It is recommended that the following signs be installed:

1. An Advisory Speed Plate (W13-1) should be added to the existing Reverse Turn Sign north of the east curve, as shown on the site sketch.
2. Chevron Alignment Signs (W1-8) should be installed around the outside of the curve, visible from both approaches, as indicated on the site sketch.

3.9.5. Long Term Improvements

Long term improvements may include complete reconstruction and widening of this curve. Additional right-of-way will be required, probably on the inside portion of the curve.

Until that time, maintenance should continue to include frequent periodic removal of trees, brush and weeds to protect the limited

sight distance available.

ACCIDENT DATA

SITE NUMBER 8

PERIOD FROM 1980 TO 1986

NUMBER OF ACCIDENTS BY YEAR

80	81	82	83	84	85	86
		3		1	1	

NUMBER OF ACCIDENTS BY DAY OF WEEK

SUN	MON	TUE	WED	THU	FRI	SAT
1		1	1		1	1

NUMBER OF ACCIDENTS BY MONTH

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1		1			1		1			1	

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

DRY	WET	SNOW	ICE	OTHER
2			3	

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

CLEAR	RAIN	SNOW	FOG	OVERCAST
4		1		

NUMBER OF ACCIDENTS
BY LIGHT CONDITIONS

DAYLIGHT	DARK	DUSK	DAWN
2	3		

NUMBER OF ACCIDENTS BY SEVERITY

	80	81	82	83	84	85	86
INJURIES						1	
FATALITIES							
P. D. O.			3		1		

NUMBER OF ACCIDENTS
BY NUMBER OF INJURIES

0	1	2	3	4	5
4					*

NUMBER OF ACCIDENTS BY NO. OF FATALITIES

0	1	2	3	4	5
5					

* ONE ACCIDENT WITH 6 INJURIES

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

ANGLE	LT - TURN	R - END	FX - OBJ	PED	ANIMAL	SDSWP	NON - COL	HD - ON
			1				1	3

0130
CD
03 JUN 87
DARK

12 MAR 82

23 JAN 82
DAYLIGHT

13 NOV 85
DAYLIGHT

17 AUG 82
DARK



SYMBOLS

- ← VEHICLE PATH
- ← PEDESTRIAN PATH
- ↔ BACKING VEHICLE
- ⊞ PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION TYPE

- ↔ REAR END
- ↔ HEAD ON
- ↔ SIDESWIPE
- ↔ OUT OF CONTROL
- ↔ RIGHT ANGLE
- ↔ LEFT TURN

CONDITIONS

TIME → 1500
DATE → 08 AUG 85
WEATHER →
PAVEMENT →
LIGHT →

WEATHER:

R = RAIN, F = FOG,
C = CLEAR, S = SNOW

PAVEMENT:

D = DRY, W = WET, I = ICY

LOCATION: JACKSON CREEK ROAD, SEC 34, T1S, R7E

PERIOD: SEVEN YEARS

FROM: 1980

TO: 1986

PREPARED BY: PETERSON

DATE: AUGUST 1987

SITE 8

DETERMINATION OF BENEFITS AND COSTS

SITE _____ 8

Estimated 5 Year Service Life
Interest Rate = 10%

1987 ADT 166
7 Years Accident Data

ANNUAL COST

Capital Cost =	1050
K=0.264	.264
M = 0	0
Annual Cost =	277

ANNUAL BENEFIT

1992 ADT (7% FOR 5 YEARS)	233	
COST PER FATAL ACCIDENT	240000	
COST PER INJURY ACCIDENT	10800	
COST OF PD ACC	1600	
I/F	19	SECONDARY ROADS
Q	22300	
Afi	.1	
Apd	.6	
Pfi	.56	
Ppd	.56	
ANNUAL BENEFIT	2506	
B/C	9.0	
INDICATOR VALUE	48	

DETERMINATION OF HAZARD INDEX

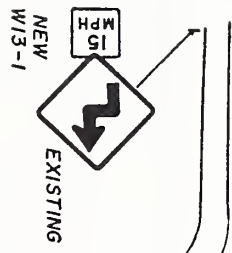
Site No.: 8

Indicator	Data Value		Indicator Value	Weight	Partial H.I.
Number of Accidents	.5	acc/yr	16 X	.164 =	2.6
Accident Rate	11.8	acc/mev	100 X	.225 =	22.5
Accident Severity	16.7	\$1000	78 X	.191 =	14.9
V/C Ratio	.18		34 X	.082 =	2.8
Sight Distance Ratio	.49		100 X	.074 =	7.4
Driver Expectancy	3.9	Rating	65 X	.149 =	9.7
Information System Deficiencies	3.7	Rating	62 X	.115 =	7.1
Hazard Index (HI)					----- 67

Benefit/Cost Indicator (BCI) 48

Priority Index = HI X 0.75 + BCI X 0.25 = 62

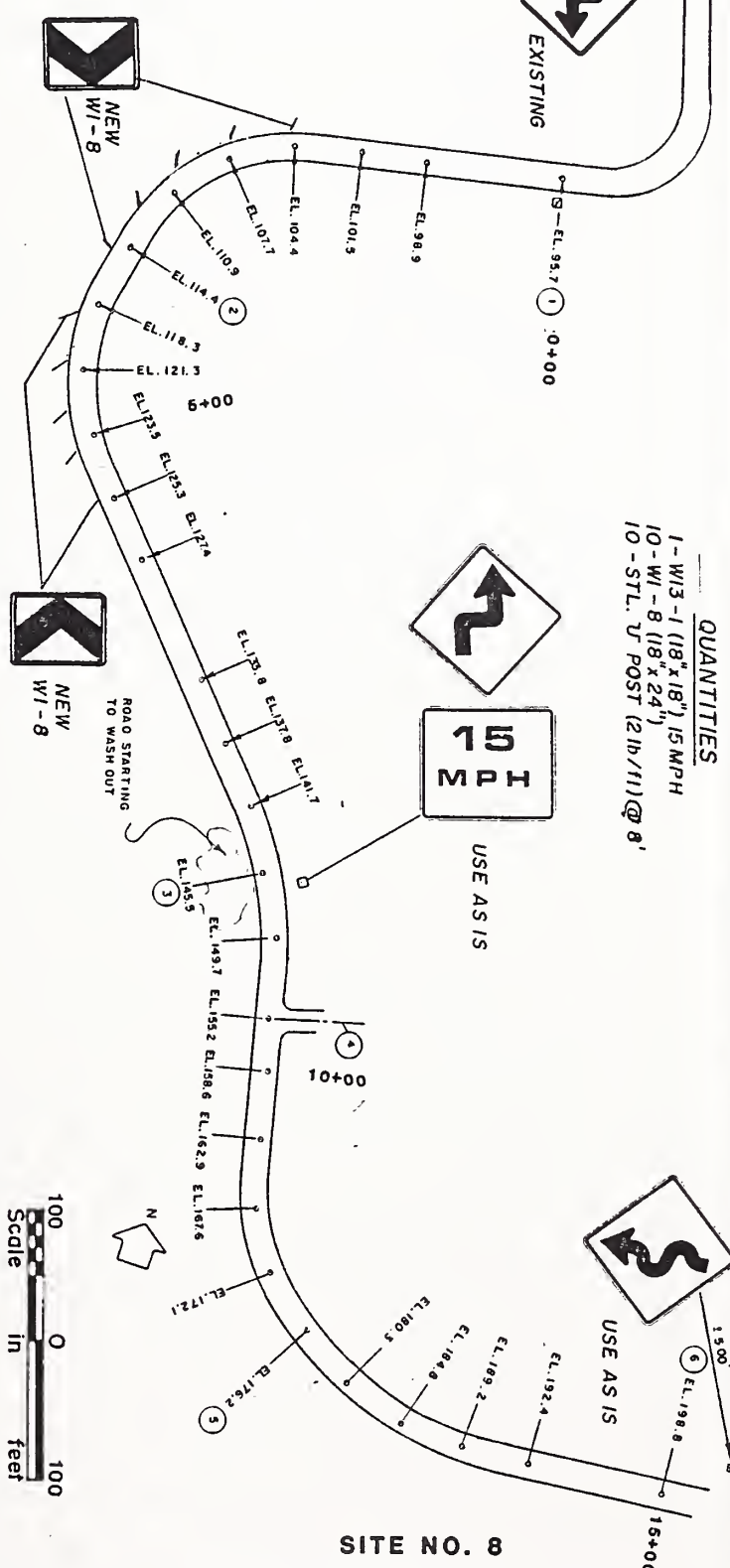
NOTE: JACKSON CREEK IS GRAVEL & NARROW



QUANTITIES
 1 - W/3-1 (18"x18") 15 MPH
 10 - W/1-8 (18"x24")
 10 - STL. U POST (24"x11") @ 8'



- LEGEND**
- Mailbox
 - ⊗ Telephone Box
 - Power Pole
 - Sign as Described
 - ▽ Guy Wire
 - Existing Elevation
 - End Post
 - Fence
 - Post/ Support Pole



SITE NO. 8

EXISTING CONDITIONS AND SHORT TERM IMPROVEMENTS



Prepared By
 Morrison-Maierle, Inc.
 Consulting Engineers

Prepared For
 Gallatin County
 Road Office, 1987

3.10. SITE 9

3.10.1. Location

This site is the "T" intersection of Baxter Lane and Flanders Mill Road in Section 3, Township 2 South, Range 5 East.

3.10.2. Existing Conditions

Baxter Road is paved with yellow centerline striping. Flanders Mill Road is gravel surfaced. There was a multi-directional Large Arrow Sign (W1-7) located as shown on the site sketch to control and warn traffic approaching on Flanders Mill Road. This sign was destroyed during the past summer. Roadway widths range from 21 feet to 23 feet, as shown on the site sketch, with no shoulders. Traffic (ADT) on the three approaches, based on 24 hour machine counts conducted in August 1987, are the following:

Baxter Lane West	470 vpd
Baxter Lane East	250 vpd
Flanders Mill Road	260 vpd

Two large, deep concrete headwall structures exist in the southwest and southeast corners of the intersection.

Site distance is greater than twice the recommended safe stopping sight distance on all approaches.

3.10.3. Accident History and Analysis

Three accidents have been recorded at the site during the 7 year period. Two involved vehicles approaching from the south and one involved a vehicle approaching from the west and failing to negotiate a turn to the right.

3.10.4. Short Term Improvements

A new T Symbol Sign (W2-4) is recommended to be placed on Flanders Mill Road at the location shown on the site sketch. Side Road Signs (W1-4) are recommended east and west of the intersection of Baxter Lane. The Large Arrow Sign (W1-7) should be replaced. Type 3 Object Markers (OM-3) are recommended to show the location of the concrete headwalls adjacent to the roadway.

The characteristics of the few accidents which have occurred do not indicate a need for a stop sign--all were single vehicle accidents. None of the other warrants for a stop sign are present.

3.10.5. Long Term Improvements

It is recommended that the existing above mentioned concrete headwalls be removed. They would be replaced by extending the pipe and installing new flared end terminal sections or other

safer, less abrupt end sections. A small amount of additional right-of-way or a construction easement will be required. Only one of the recorded accidents involved a collision with one of the headwalls and only a minor injury resulted. There is a potential, however, that an otherwise minor incident involving a vehicle leaving the road could become much more serious if the vehicle drops into the ditch and collides with a headwall.

ACCIDENT DATA

SITE NUMBER 9

PERIOD FROM 1980 TO 1986

NUMBER OF ACCIDENTS BY YEAR

80	81	82	83	84	85	86
	2				1	

NUMBER OF ACCIDENTS BY DAY OF WEEK

SUN	MON	TUE	WED	THU	FRI	SAT
1		1				1

NUMBER OF ACCIDENTS BY MONTH

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2								1			

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

DRY	WET	SNOW	ICE	OTHER
2			1	

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

CLEAR	RAIN	SNOW	FOG	OVERCAST
3				

NUMBER OF ACCIDENTS
BY LIGHT CONDITIONS

DAYLIGHT	DARK	DUSK	DAWN
	2		1

NUMBER OF ACCIDENTS BY SEVERITY

	80	81	82	83	84	85	86
INJURIES						1	
FATALITIES							
P. D. O.		2					

NUMBER OF ACCIDENTS
BY NUMBER OF INJURIES

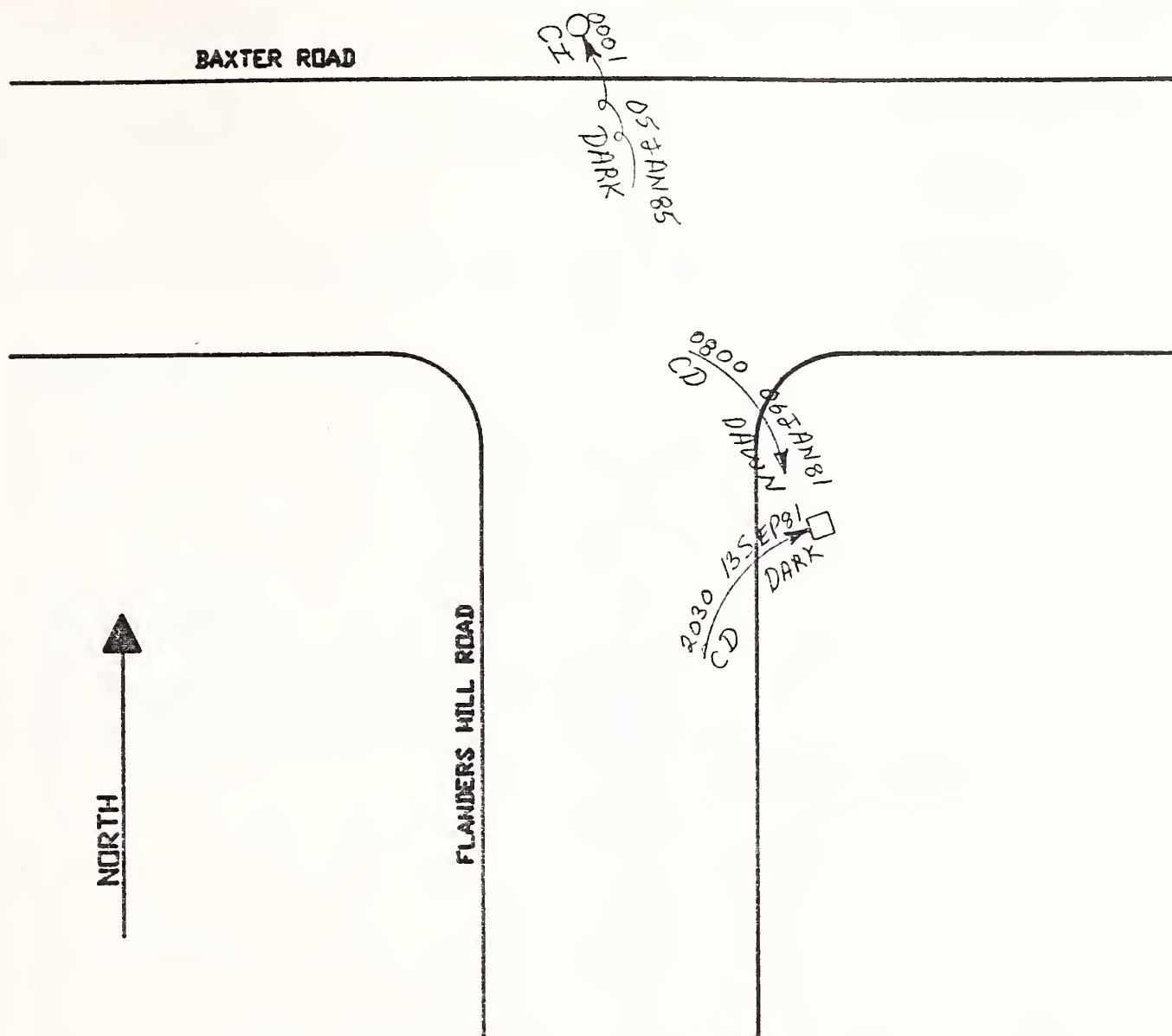
0	1	2	3	4	5
2	1				

NUMBER OF ACCIDENTS BY NO. OF FATALITIES

0	1	2	3	4	5
3					

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

ANGLE	LT - TURN	R - END	FX - OBJ	PED	ANIMAL	SDSWP	NON - COL	HD - ON
			1				2	



SYMBOLS

- ← VEHICLE PATH
- ← PEDESTRIAN PATH
- ↔ BACKING VEHICLE
- ☒ PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION TYPE

- ↔ REAR END
- HEAD ON
- ↗ SIDESWIPE
- ↪ OUT OF CONTROL
- ⊥ RIGHT ANGLE
- ↪ LEFT TURN

CONDITIONS

TIME → 1500
 DATE → 08 AUG 85
 WEATHER → DARK
 PAVEMENT →

WEATHER:

R = RAIN, F = FOG,
 C = CLEAR, S = SNOW

PAVEMENT:

D = DRY, W = WET, I = ICY

LOCATION: INTERSECTION BAXTER ROAD & FLANDERS HILL ROAD, SEC 3, T2S, R5E

SITE 9

PERIOD: SEVEN YEARS

FROM: 1980

TO: 1986

PREPARED BY: PETERSON

DATE: AUGUST 1987

DETERMINATION OF BENEFITS AND COSTS

SITE _____ 9

Estimated 5 Year Service Life
Interest Rate = 10%

1987 ADT 486
7 Years Accident Data

ANNUAL COST *****

Capital Cost =	1160
K=0.264	.264
M = 0	0
Annual Cost =	306

ANNUAL BENEFIT *****

1992 ADT (7% FOR 5 YEARS)	682	
COST PER FATAL ACCIDENT	240000	
COST PER INJURY ACCIDENT	10800	
COST OF PD ACC	1600	
I/F	19	SECONDARY ROADS
Q	22300	
Afi	.1	
Apd	.3	
Pfi	.60	
Ppd	.60	
ANNUAL BENEFIT	2281	
B/C	7.4	
INDICATOR VALUE	44	

DETERMINATION OF HAZARD INDEX

Site No.: 9

Indicator	Data Value		Indicator Value	Weight	Partial H.I.
-----	-----		-----	-----	-----
Number of Accidents	.4	acc/yr	13 X	.164 =	2.1
Accident Rate	2.4	acc/mev	40 X	.225 =	9.0
Accident Severity	12.3	\$1000	69 X	.191 =	13.2
V/C Ratio	.19		36 X	.082 =	3.0
Sight Distance Ratio	2.00		0 X	.074 =	
Driver Expectancy	3.3	Rating	55 X	.149 =	8.2
Information System Deficiencies	3.7	Rating	62 X	.115 =	7.1

Hazard Index (HI)					43

Benefit/Cost Indicator (BCI) 44

Priority Index = HI X 0.75 + BCI X 0.25 = 43



Prepared For
Gallatin County

Road Office, 1987

3.11. SITE 10

3.11.1. Location

Site 10 is the intersection of Haggerty Lane, Bozeman Trail and Sunset Boulevard in Sections 16 & 17, Township 2 South, Range 6 East.

3.11.2. Existing Conditions

Haggerty Lane, Sunset Blvd., and Bozeman Trail south of the intersection are paved. Pavement widths are as shown on the site sketch. Bozeman Trail north of the intersection provides limited residential access and is not paved. Haggerty to south Bozeman Trail is the through movement with Sunset Blvd. and north Bozeman Trail controlled by Stop Signs (R1-1).

ADT is estimated as follows, based on August 1987 24 hour machine counts:

Haggerty Lane	1680 vpd
Sunset Blvd.	590 vpd
Bozeman Trail, So.	470 vpd

Centerline striping, with appropriate no-passing striping, is in place. Signing includes the above mentioned Stop Signs (R1-1) on Sunset and North Bozeman Trail, a Turn Sign (W1-1) on Haggerty Lane west of the intersection and a Turn Sign (W1-2) with a 20 mph Advisory Speed Plate (W13-1) on Bozeman Trail south of the intersection. A non-standard School Bus Stop Ahead Sign is located just south of the site.

Using guidelines included on page 166 of the AASHTO "Green Book", it was determined using a ball-bank indicator that safe speeds on the curve are approximately 20 mph for either direction of travel.

Vertical grades vary but are not excessive and do not seem to be a contributing factor. Site distance is greater than twice the recommended safe stopping sight distance.

3.11.3. Accident History and Analysis

Three accidents were recorded during the 7 year period, all of which included vehicles failing to negotiate the right turn from Haggerty to south Bozeman Trail. Two were single vehicle accidents and one was a head-on with a second vehicle. Only one, the head-on, involved icy or snow covered roads and only one was after dark.

3.11.4. Short Term Improvements

The following revisions and/or additions to warning signs are recommended:

1. Add a 20 mph Advisory Speed Plate (W13-1) to the existing Turn Sign (W1-1) on Haggerty Lane west of the intersection.
2. Install a Large Arrow Sign (W1-6) at the location shown on the site sketch to emphasize the curve to traffic approaching from the west on Haggerty Lane.
3. Replace the non-standard sign with a new School Bus Stop Ahead Sign (S3-1).

3.11.5. Long Term Improvements

No long term improvements are recommended.

ACCIDENT DATA

SITE NUMBER 10

PERIOD FROM 1980 TO 1986

NUMBER OF ACCIDENTS BY YEAR

80	81	82	83	84	85	86
		1		1	1	

NUMBER OF ACCIDENTS BY DAY OF WEEK

SUN	MON	TUE	WED	THU	FRI	SAT
	1					2

NUMBER OF ACCIDENTS BY MONTH

JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
				1	1						1

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

DRY	WET	SNOW	ICE	OTHER
2		1		

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

CLEAR	RAIN	SNOW	FOG	OVERCAST
2				1

NUMBER OF ACCIDENTS
BY LIGHT CONDITIONS

DAYLIGHT	DARK	DUSK	DAWN
2	1		

NUMBER OF ACCIDENTS BY SEVERITY

	80	81	82	83	84	85	86
INJURIES							
FATALITIES							
P. D. O.			1		1	1	

NUMBER OF ACCIDENTS
BY NUMBER OF INJURIES

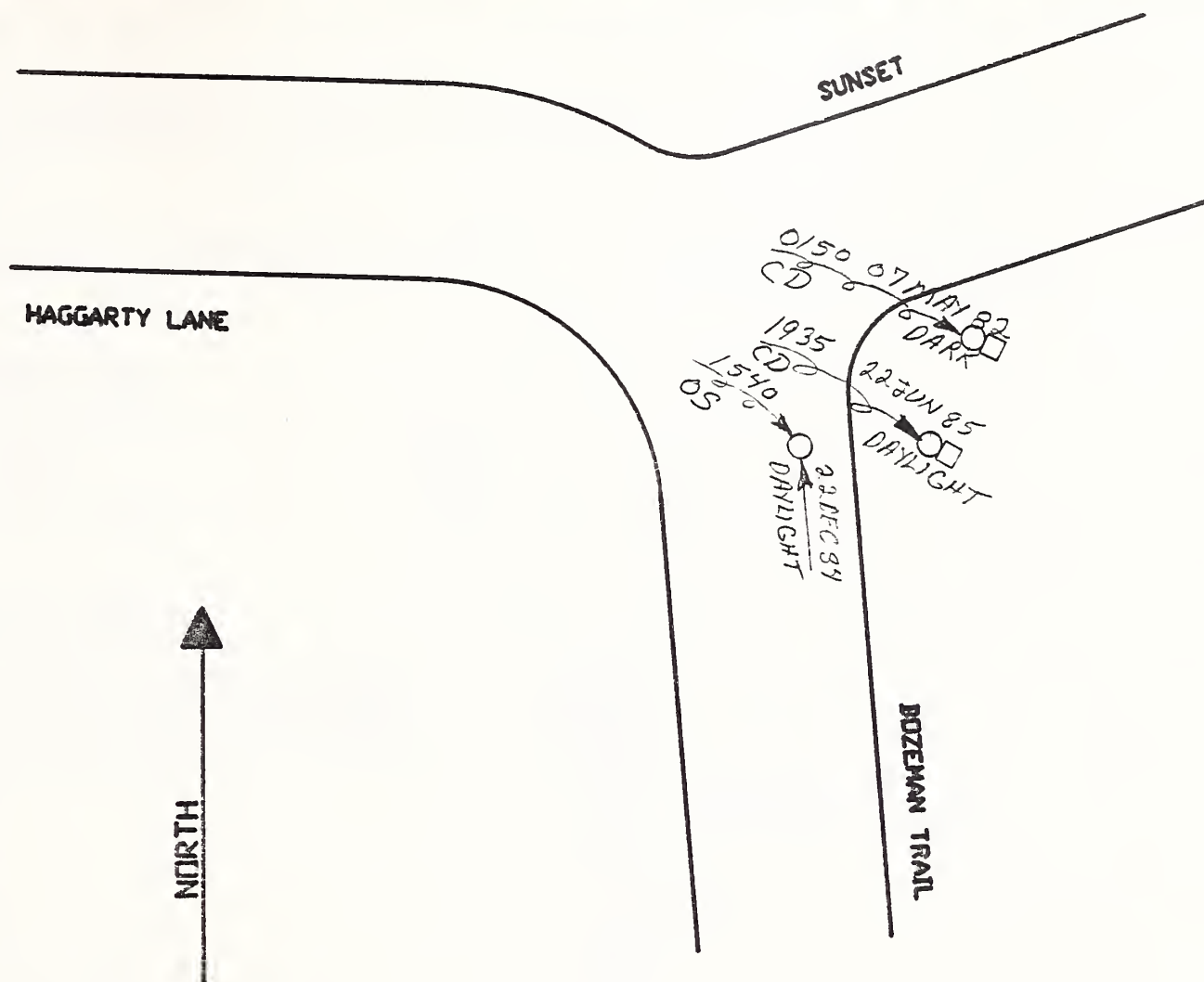
0	1	2	3	4	5
	2			1	

NUMBER OF ACCIDENTS BY NO. OF FATALITIES

0	1	2	3	4	5
3					

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

ANGLE	LT - TURN	R - END	FX - OBJ	PED	ANIMAL	SDSWP	NON - COL	HD - ON
			2					1



SYMBOLS

- ← VEHICLE PATH
- ← PEDESTRIAN PATH
- ↔ BACKING VEHICLE
- ▣ PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION TYPE

- ↔ REAR END
- ↔ HEAD ON
- ↔ SIDESWIPE
- ↔ OUT OF CONTROL
- ↔ RIGHT ANGLE
- ↔ LEFT TURN

CONDITIONS

TIME → 1300 → DATE → 08 AUG 85
 ← R V ← DARK
 WEATHER →
 PAVEMENT → LIGHT

WEATHER:

R = RAIN, F = FOG,
 C = CLEAR, S = SNOW

PAVEMENT:

D = DRY, W = WET, I = ICY

LOCATION: HAGGARTY, SUNSET, BOZEMAN TRAIL INTERSECTION, SEC 16, T2S, R6E

SITE 10

PERIOD: SEVEN YEARS

FROM: 1980

TO: 1986

PREPARED BY: PETERSON

DATE: AUGUST 1987

DETERMINATION OF BENEFITS AND COSTS

SITE _____ 10

Estimated 5 Year Service Life
Interest Rate = 10%

1987 ADT 1370
7 Years Accident Data

ANNUAL COST

Capital Cost =	330
K=0.264	.264
M = 0	0
Annual Cost =	87

ANNUAL BENEFIT

1992 ADT (7% FOR 5 YEARS)	1921
COST PER FATAL ACCIDENT	240000
COST PER INJURY ACCIDENT	10800
COST OF PD ACC	1600
I/F	19
Q	22300
Afi	.4
Apd	.0
Pfi	.48
Ppd	.48
ANNUAL BENEFIT	6005

SECONDARY ROADS

B/C	68.9
-----	------

INDICATOR VALUE	92
-----------------	----

DETERMINATION OF HAZARD INDEX

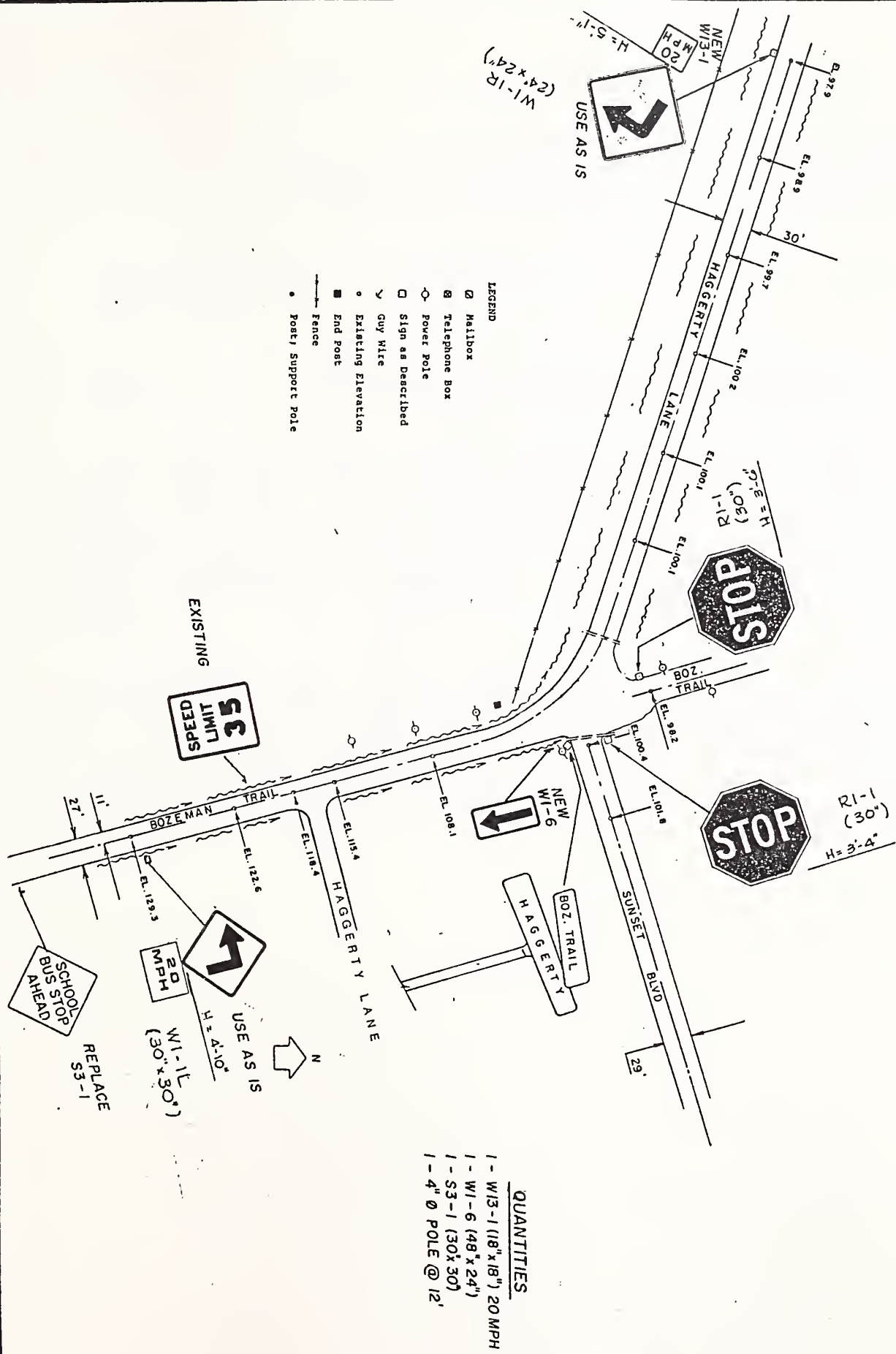
Site No.: 10

Indicator	Data Value		Indicator Value	Weight	Partial H.I.
-----	-----		-----	-----	-----
Number of Accidents	.4	acc/yr	13 X	.164 =	2.1
Accident Rate	.9	acc/mev	16 X	.225 =	3.6
Accident Severity	13.0	\$1000	71 X	.191 =	13.6
V/C Ratio	.08		23 X	.082 =	1.9
Sight Distance Ratio	1.54		9 X	.074 =	.7
Driver Expectancy	2.6	Rating	43 X	.149 =	6.5
Information System Deficiencies	2.2	Rating	37 X	.115 =	4.2

Hazard Index (HI)					33

Benefit/Cost Indicator (BCI) 92

Priority Index = HI X 0.75 + BCI X 0.25 = 48



SITE NO. 10

EXISTING CONDITIONS AND SHORT TERM IMPROVEMENTS



Prepared By
Morrison-Haierle, Inc.
Consulting Engineers

Prepared For
Gallatin County
Road Office, 1987

4. APPENDIX A - CONSTRUCTION AND PLACEMENT OF SIGNS

All signing should be constructed and placed in accordance with the Manual on Uniform Traffic Control Devices (MUTCD) and should be placed in the locations shown on the site sketches of this report. Copies of the MUTCD are available from:

Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402

Warning signs should be placed at the minimum distances indicated in "Table II-1 -- A guide for Advance Warning Sign Placement Distance" of the MUTCD. A copy is included on following pages.

The following drawings, from "Standard Drawings", 1984 Edition, Montana Department of Highways, indicate standard clearance and mounting heights, typical approach road signing, treated timber pole details and delineator design. These standards, along with information provided in previous sections of this report, should provide sufficient information to allow county maintenance personnel to order materials and install the recommended improvements.

If wood posts are used, consideration should be given to installing the signs so that the bottom edge of the bottom sign panel is at least 7 feet above the roadway and the top of the post is at least 9 feet above the roadway. Studies have shown that shorter wood posts, when hit, tend to shear at the base and then swing into the automobile windshield. Longer wood posts sometimes prevent this.

TABLE II-1—A Guide For Advance Warning Sign Placement Distance¹

Posted or 85 percentile speed MPH	Condition A high	General warning signs ³					
	judg- ment needed ⁵ (10 secs. PIEV)	Condition B—Stop condition	Condition C—Deceleration condition to listed advisory speed—MPH (or desired speed at condition)				
		0	10	20	30	40	50
20	⁵ 175	(⁴)	(⁴)	.....	.....	.....	.....
25	250	(⁴)	² 100	.....	.....	.....	.....
30	325	⁵ 100	150	⁵ 100	.....	.....	.....
35	400	150	200	175	.....	.....	.....
40	475	225	275	250	⁵ 175	.....	.....
45	550	300	350	300	250	.....	.....
50	625	375	425	400	325	⁵ 225	.....
55	700	450	500	475	400	300	.....
60	775	550	575	550	500	400	⁵ 300

Typical Signs for the Listed Conditions in Table II-1; Condition A—Merge, Right Lane Ends, etc.; Condition B—Cross Road, Stop Ahead, Signal Ahead, Ped-Xing, etc.; Condition C—Turn, Curve, Divided Road, Hill, Dip, etc.

1 Distances shown are for level roadways. Corrections should be made for grades. If 48-inch signs are used, the legibility distance may be increased to 200 feet. This would allow reducing the above distance by 75 feet.

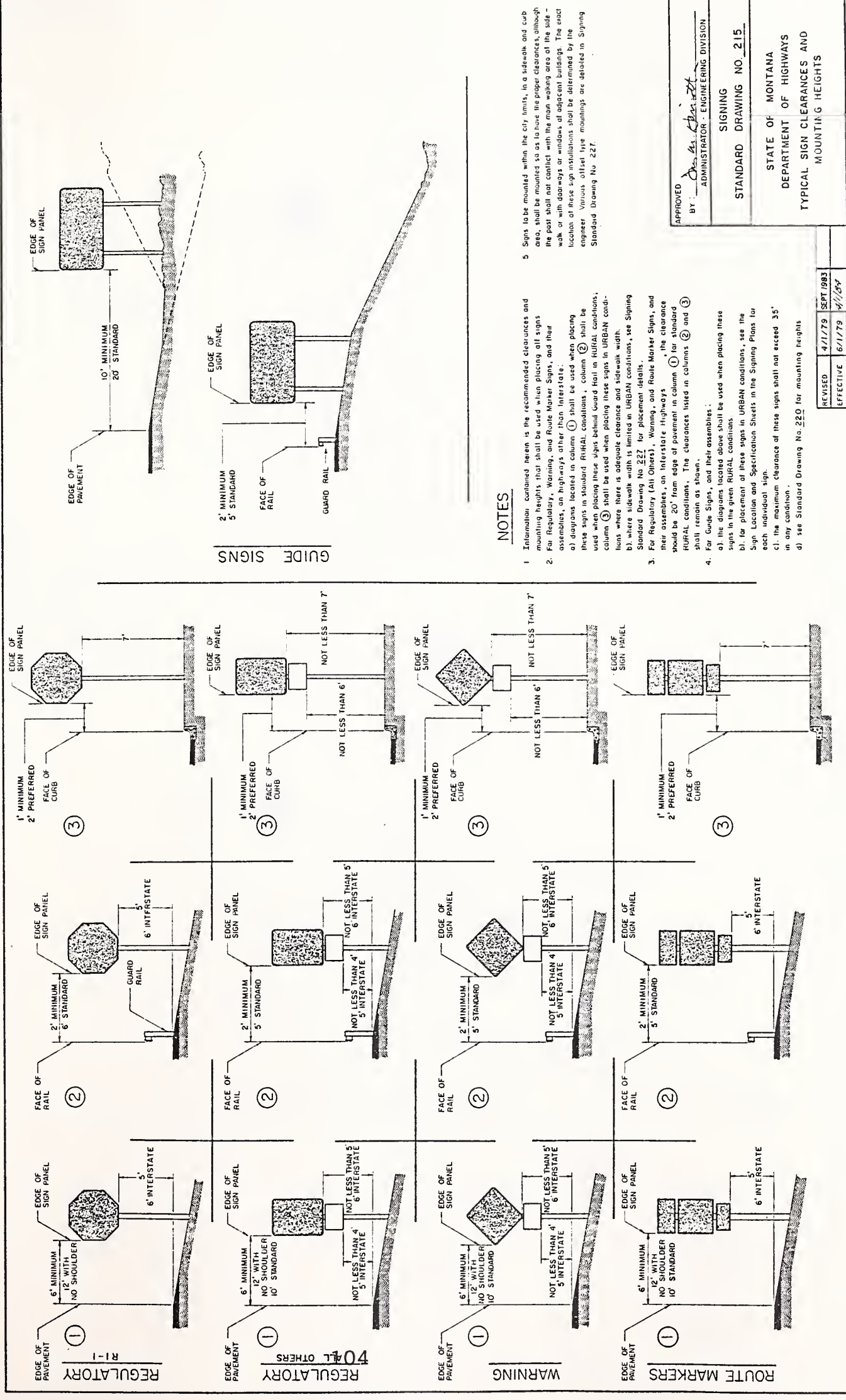
2 In urban areas, a supplementary plate underneath the warning sign should be used specifying the distance to the condition if there is an in-between intersection which might confuse the motorist.

3 Distance provides for 3-second PIEV, 125 feet Sign Legibility Distance, Braking Distance for Condition B and Comfortable Braking Distance for condition C as indicated in *A Policy on Geometric Design of Highways and Streets*, 1984, AASHTO, Figure II-13.

4 No suggested minimum distance provided. At these speeds, sign location depends on physical conditions at site.

5 Feet

II-4 (c)



GUIDE SIGNS

NOTES

1. Information contained herein is the recommended clearances and mounting heights that shall be used when placing all signs.
2. For Regulatory, Warning, and Route Marker Signs, and their assemblies, on highways other than Interstate:
 - a) diagrams located in column ① shall be used when placing these signs in standard RURAL conditions, column ② shall be used when placing these signs behind guard rail in RURAL conditions, column ③ shall be used when placing these signs in URBAN conditions, where there is adequate clearance and sidewalk width.
 - b) where sidewalk width is limited in URBAN conditions, see Signing Standard Drawing No. 227 for placement details.
3. For Regulatory (All Others), Warning, and Route Marker Signs, and their assemblies, on Interstate Highways, the clearance should be 20' from edge of pavement in column ① for standard RURAL conditions. The clearances listed in columns ② and ③ shall remain as shown.
 - a) the diagrams located above shall be used when placing these signs in the given RURAL conditions.
 - b) for placement of these signs in URBAN conditions, see the Sign Location and Specification Sheets in the Signing Plans for each individual sign.
 - c) the maximum clearance of these signs shall not exceed 35' in any condition.
 - d) see Standard Drawing No. 220 for mounting heights.
4. For Guide Signs, and their assemblies:
 - a) the diagrams located above shall be used when placing these signs in the given RURAL conditions.
 - b) for placement of these signs in URBAN conditions, see the Sign Location and Specification Sheets in the Signing Plans for each individual sign.
 - c) the maximum clearance of these signs shall not exceed 35' in any condition.
 - d) see Standard Drawing No. 220 for mounting heights.

5. Signs to be mounted within the city limits, in a sidewalk and curb area, shall be mounted so as to have the proper clearances, although the post shall not conflict with the main working area of the sidewalk or with doorways or windows of adjacent buildings. The exact location of these sign installations shall be determined by the engineer. Various offset type mountings are detailed in Signing Standard Drawing No. 227.

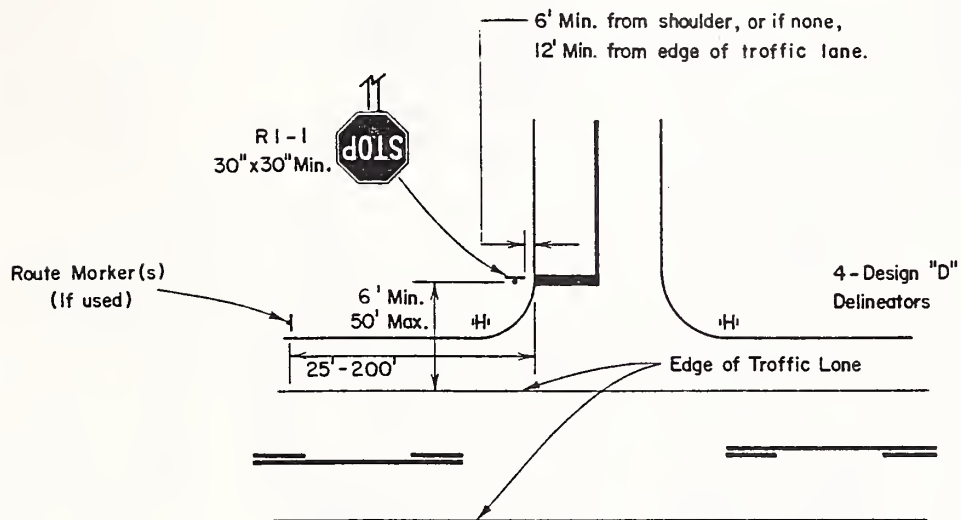
APPROVED BY: *[Signature]*
 ADMINISTRATOR, ENGINEERING DIVISION

SIGNING
 STANDARD DRAWING NO. 215

STATE OF MONTANA
 DEPARTMENT OF HIGHWAYS
 TYPICAL SIGN CLEARANCES AND MOUNTING HEIGHTS

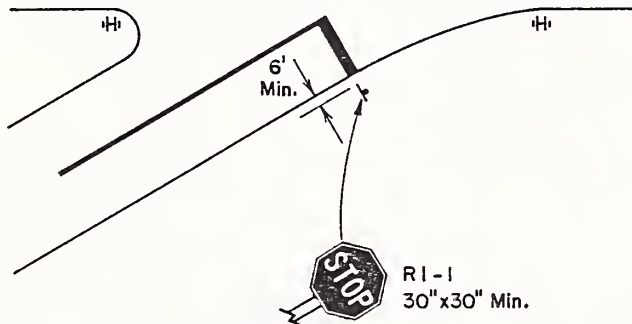
REVISED	4/1/79	SEPT 1983
EFFECTIVE	6/1/79	4/1/84

TYPICAL APPROACH ROAD SIGNING

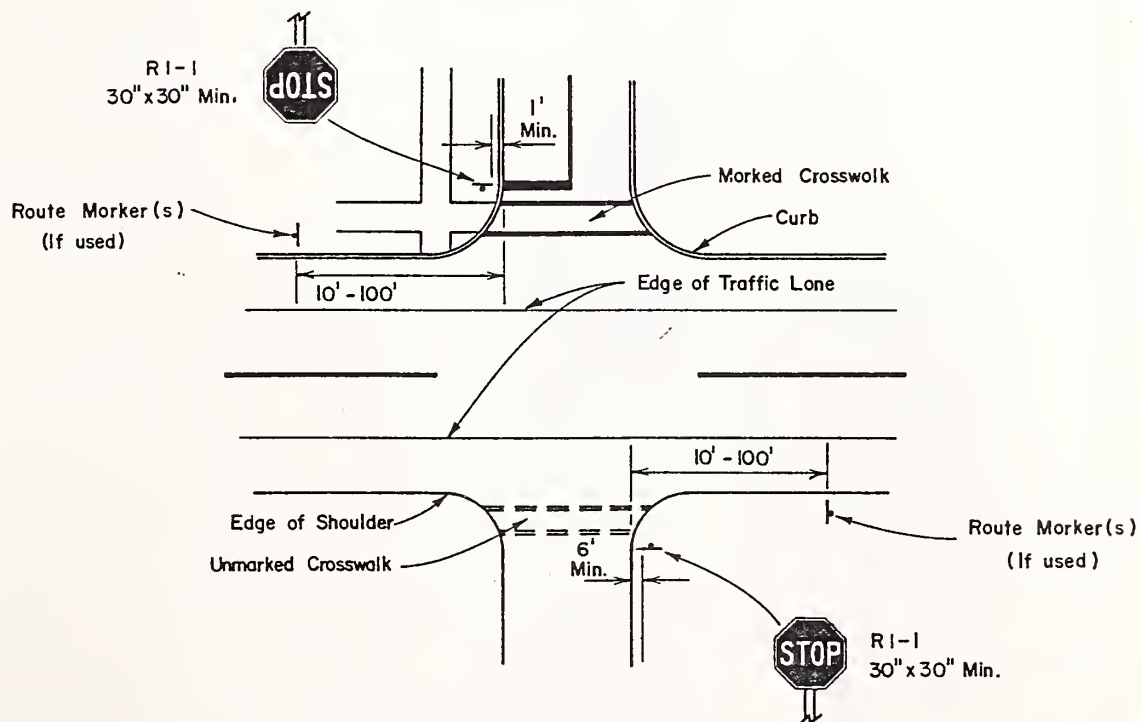


NOTE:

Place R1-1 Sign at the beginning of curb radius, or shoulder radius, or 4 feet min. In advance of the marked or unmarked Crosswalk.



RURAL



URBAN

SIGNING STANDARD
DRAWING NUMBER 216

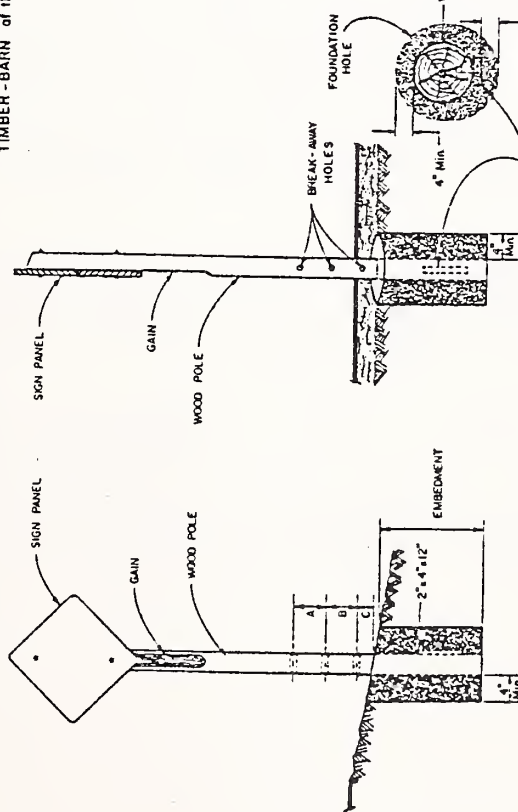
TYPICAL
RURAL AND URBAN
APPROACH

REVISED 5/4/1/79
EFFECTIVE 6/1/79

APPROVED BY *[Signature]*
ADMINISTRATOR - ENGINEERING DIVISION

NOTES:

1. All Timber Poles shall conform to the 1976 State of Montana Department of Highways Standard Specifications.
2. All Timber Poles shall be full pressure treated as per the Standard Specifications.
3. All cutting, trimming, and boring of Treated Poles shall conform and be in accordance with the Standard Specifications.
4. All Poles shall be gained on the sign side a minimum as shown in the Table below for 1/2 the length of each pole as shown.
5. Break Away Details shall be standard for all Timber Wood



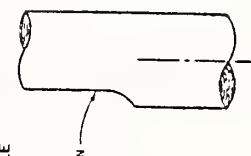
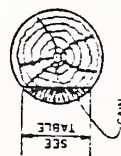
BREAK-AWAY AND FOOTING DETAILS

POLE SIZE	A	B	C	HOLE DIA	EMBEDMENT	GAIN
3" TOP Ø	1"	1"	1"	2"	3'-0"	2'-3 1/4"
4" TOP Ø	1"	1"	1"	2"	3'-0"	3'-1 1/2"
5" TOP Ø	1"	1"	1"	2"	3'-6"	4"
6" TOP Ø	1"	1"	1"	2"	4'-6"	4"
CLASS 4	1"	1"	1"	2"	5'-0"	4"
CLASS 3	1"	1"	1"	2 1/2"	5'-6"	4"
CLASS 2	1"	1"	1"	2"	6'-0"	4"
CLASS 1	1"	1"	1"	2 1/2"	6'-6"	4"

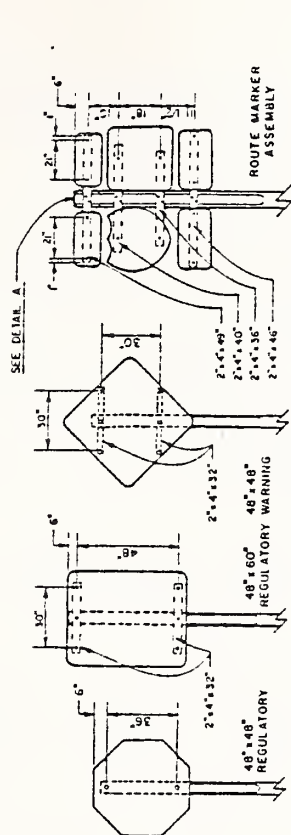
6. Poles listed in the Table below, either on single or multiple sign supports.
7. All Back Bracing material shall be of Standard No. 2 or better grade S 4 S lumber, and shall meet all spec's listed in Section M-320.01 of the Standard Specifications.
8. All bolts, nuts, and washers shall be of Aluminum, Stainless Steel, or Cadmium Plated Steel material.
9. A 2" x 4" x 12" board shall be attached 12" from the bottom of the Pole. Attachment shall be made by driving two nails (16 d) through the 2" x 4" and into the Pole. The 2" x 4" shall be treated according to the Standard Specifications. The cost for all material and labor to accomplish this work shall be included in the Item -- POLES - TREATED TIMBER - BARN of the contract.



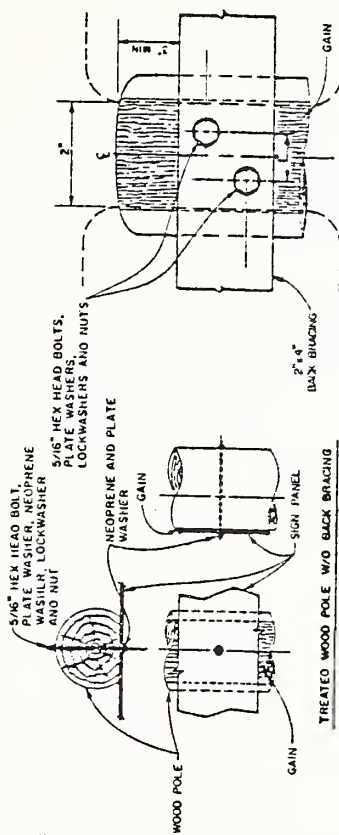
TOP END TREATMENT



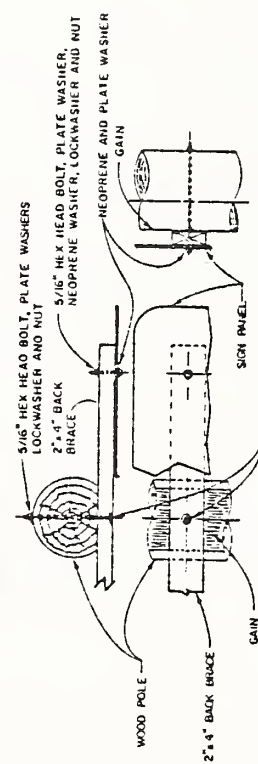
GAIN DETAIL



TYPICAL SIGN MOUNTINGS



DETAIL A



TREATED WOOD POLE WITH BACK BRACING

APPROVED BY: *[Signature]*
ADMINISTRATOR - ENGINEERING DIVISION

SIGNING
STANDARD DRAWING NO. 228

STATE OF MONTANA
DEPARTMENT OF HIGHWAYS
TREATED TIMBER POLE
SIGN SUPPORT DETAILS

REVISED	DATE	BY	CHECKED	DATE	BY
1	2/11/79	JLH	2/11/79	JLH	

FLEXIBLE DELINEATORS

Delineators shall be an approved flexible type as described herein. The cross-sectional shape and material composition of the posts shall be of the contractor's choice, subject to conformance with these specifications and the approval of the engineer, however, posts of hollow triangular or round cross-section will not be acceptable.

Flexible delineators shall meet the following requirements:

1. The post shall be self-erecting after withstanding 10 vehicle impacts at temperatures of 0° F. and above without complete loss of serviceability. The impacts shall be made at an impact angle of $25^{\circ} \pm 5^{\circ}$ and at a vehicle speed of 35 m.p.h. by a typical, American-made sedan.
2. The minimum width shall be 3-5/8 in., and the maximum wall thickness shall be 0.125 inches.
3. The post shall be opaque white in color, colorfast, and shall be designed to provide an essentially flat or a concave or convex surface to accommodate 3 inch wide, impact-resistant reflective sheeting on one or both sides.
4. The posts shall be capable of being driven into the ground employing the methods recommended by the manufacturer. The post shall be driven to a depth of not less than 2 feet and shall be plumb.
5. Posts shall exhibit good workmanship and shall be free of surface porosity and other objectional marks and defects that may affect appearance or serviceability.
6. Delineator placement and spacing, post lengths, installation heights and clearances, and requirements for reflective sheeting shall be in accordance with Standard Drawing No. 242. Design A Delineator shall be a 3 by 6 inch silver reflective sheeting on one side, Design F, a 3 by 6 inch silver reflective sheeting on both sides, and Design D a 3 by 12 in amber reflective sheeting on both sides.
7. A certified test report and test data shall be provided, developed by an approved laboratory and attesting to the fact that the posts proposed for use on the project comply with all requirements of this specification.

Samples of the product proposed for use on the project shall be supplied to the engineer upon request.

Flexible delineator post will be measured by the number of each type specified, installed and accepted, complete with reflectors.

Flexible delineator posts will be paid for at the contract unit price per each.

5. APPENDIX B - COST ESTIMATES FOR SHORT TERM IMPROVEMENTS

COST ESTIMATES - 28 OCT. 1987

QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
		***** SITE 1 *****		
3	EACH	SIGNS, 6.1 - 10 SF	\$140	\$420
2	EACH	SIGNS, 1 - 6 SF, PLATE ONLY	\$50	\$100
2	EACH	RAISE/RELOCATE EXIST SIGN	\$90	\$180
18	EACH	DESIGN F FLEX DELIN POSTS	\$20	\$360

				\$1,060
		***** SITE 2W *****		
6	EACH	RAISE/RELOCATE EXIST SIGN	\$90	\$540
1	EACH	SIGNS, 6.1 - 10 SF	\$140	\$140
1	EACH	SIGNS, 1 - 6 SF	\$100	\$100

				\$780
		***** SITE 2E *****		
3	EACH	SIGNS, 6.1 - 10 SF	\$140	\$420
1	EACH	GUIDE SIGN (2-POST)	\$200	\$200
2	EACH	DESIGN D DELIN	\$20	\$40

				\$660
		***** SITE 4 *****		
1	EACH	SIGNS, 10 - 20 SF	\$170	\$170
1	EACH	SIGNS, 6.1 - 10 SF	\$140	\$140
1	EACH	REMOVE SIGN	\$30	\$30

				\$340
		***** SITE 5 *****		
4	EACH	SIGNS, 6.1 - 10 SF	\$140	\$560
2	EACH	DESIGN D DELIN	\$20	\$40

				\$600
		***** SITE 6 *****		
4	EACH	SIGNS, 6.1 - 10 SF	\$140	\$560

				\$560
		***** SITE 7 *****		
17	EACH	DESIGN F FLEX DELIN POSTS	\$20	\$340

				\$340
		***** SITE 8 *****		
10	EACH	SIGNS, 1 - 6 SF	\$100	\$1,000
1	EACH	SIGN, 1 - 6 SF, PLATE ONLY	\$50	\$50

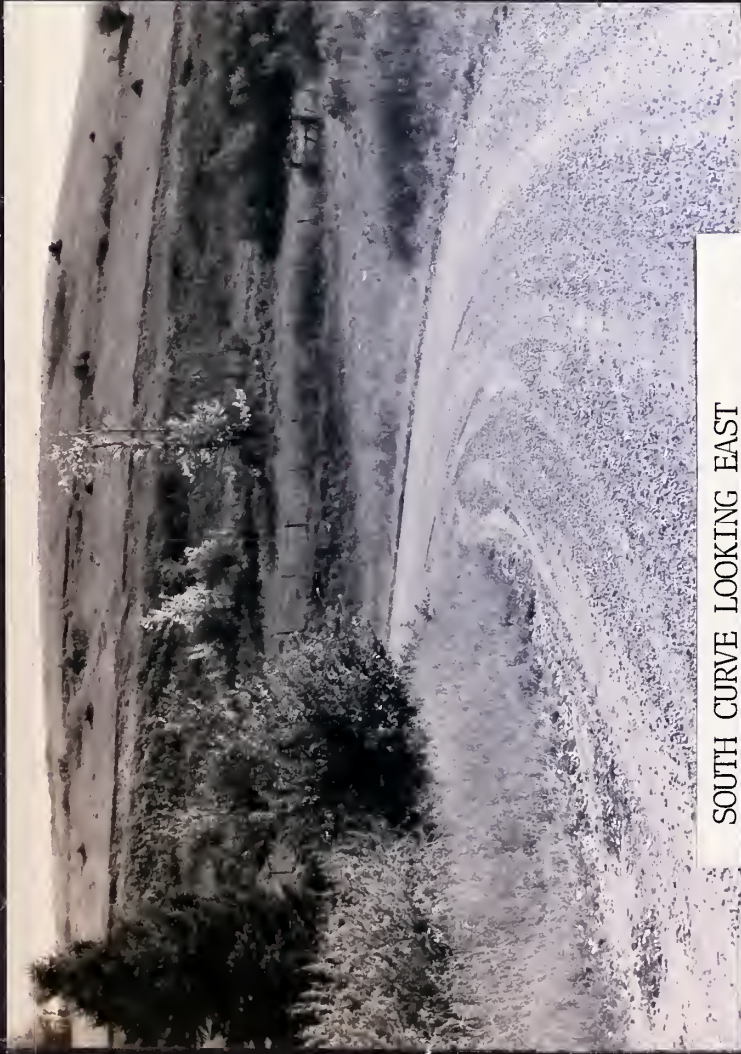
				\$1,050
		***** SITE 9 *****		
6	EACH	SIGNS, 1 - 6 SF	\$100	\$600
4	EACH	SIGNS, 6.1 - 10 SF	\$140	\$560

				\$1,160
		***** SITE 10 *****		
1	EACH	SIGNS, 1 - 6 SF, PLATE ONLY	\$50	\$50
2	EACH	SIGNS, 6.1 - 10 SF	\$140	\$280

				\$330

Note: Unit prices based on 24 March 1987 letter, FHWA to MDOH.

6. APPENDIX C - PHOTOGRAPHS



SOUTH CURVE LOOKING EAST



SOUTH CURVE LOOKING SOUTHWEST



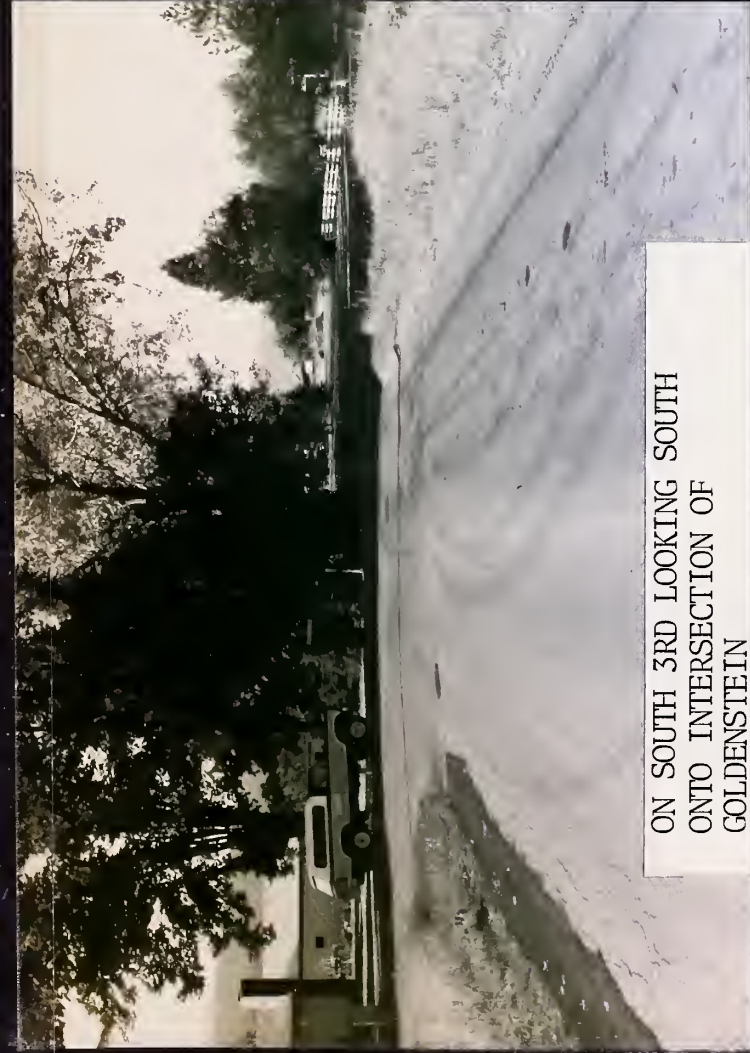
NORTH CURVE LOOKING NORTHEAST
SHOWING SIGHT DISTANCE TO
ONCOMING TRAFFIC



NORTH CURVE LOOKING WEST SHOWING
BLIND SPOT ON LEFT



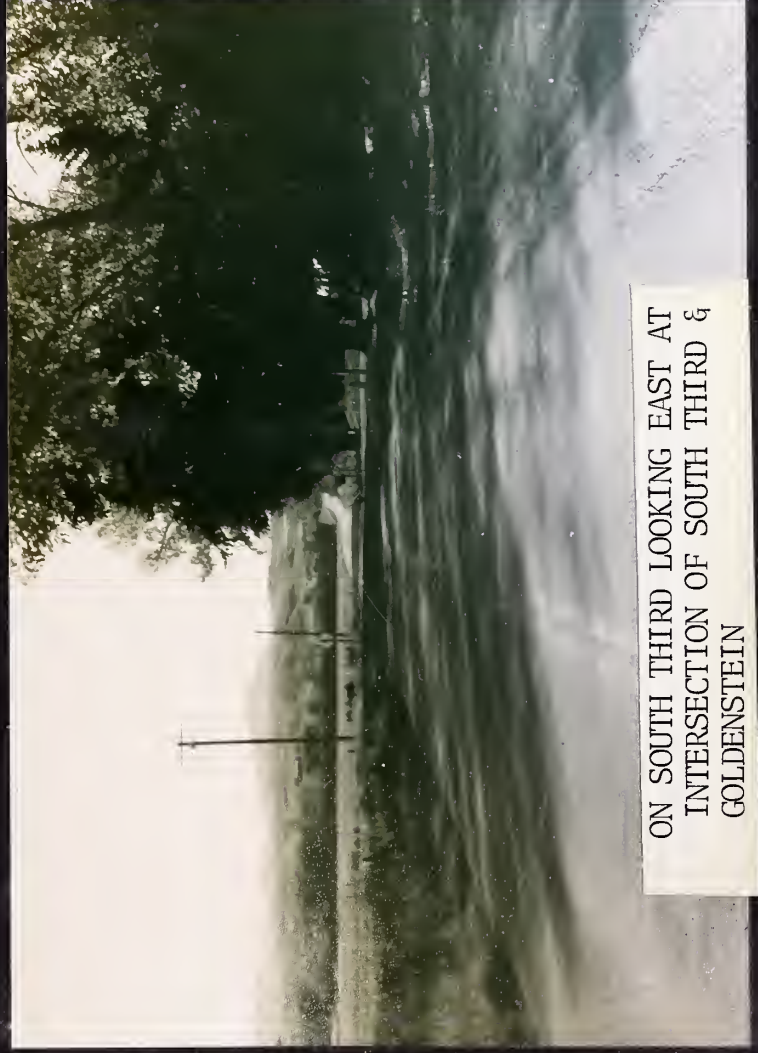
NORTH CURVE LOOKING WEST SHOWING
BLIND SPOT ON LEFT



ON SOUTH 3RD LOOKING SOUTH
ONTO INTERSECTION OF
GOLDENSTEIN



ON GOLDENSTEIN LOOKING WEST
AT INTERSECTION OF SOUTH 3RD



ON SOUTH THIRD LOOKING EAST AT
INTERSECTION OF SOUTH THIRD &
GOLDENSTEIN



LOOKING WEST AT CURVE APPROACH
TO GO SOUTH ON SOUTH THIRD



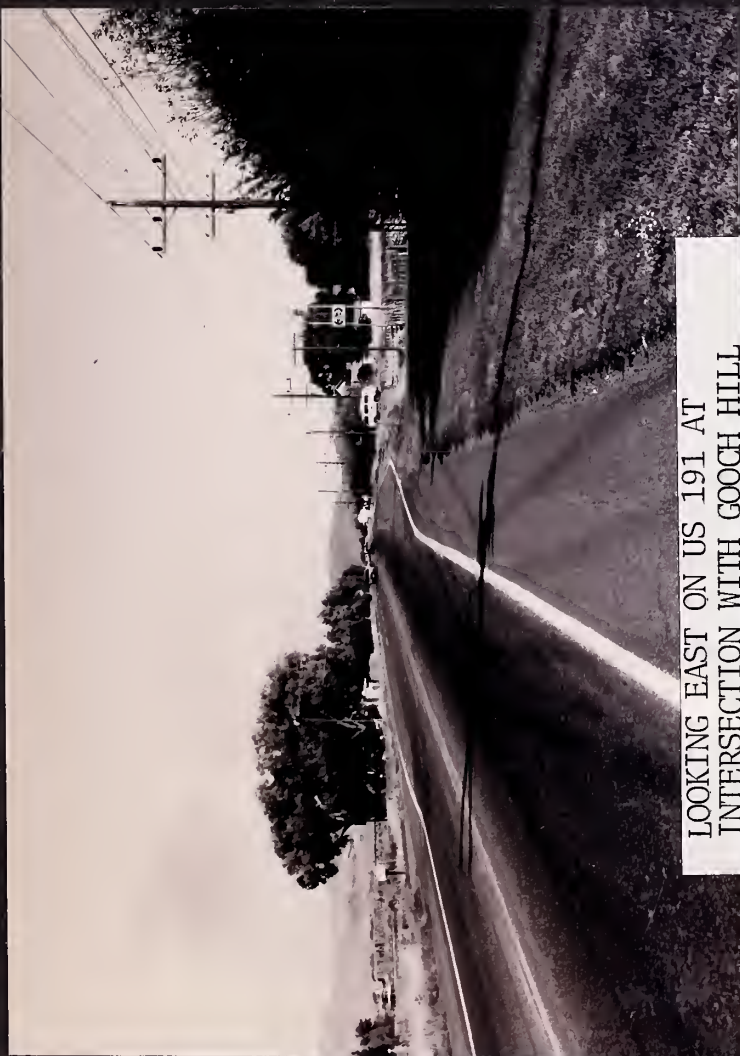
LOOKING SOUTHWEST SHOWING CURVE
SUPERELEVATION & SIGHT DISTANCE



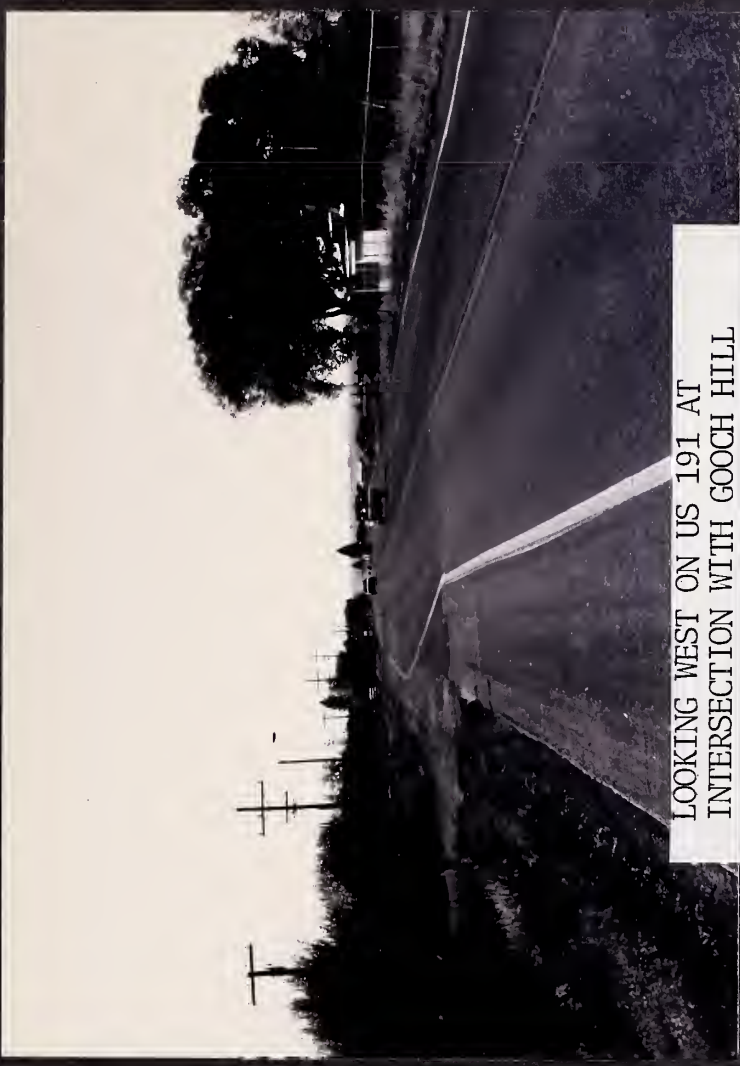
LOOKING NORTHEAST SHOWING
CURVE SUPERELEVATION



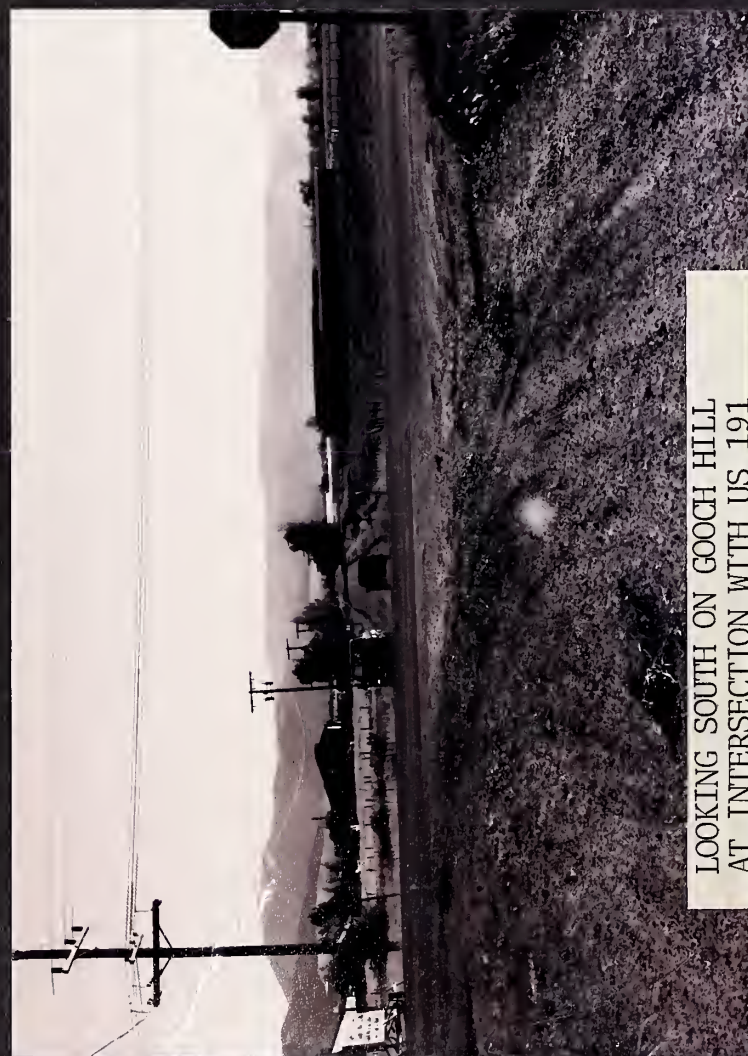
LOOKING NORTH AT CURVE APPROACH
TO GO EAST ON SOUTH THIRD



LOOKING EAST ON US 191 AT
INTERSECTION WITH GOOCH HILL



LOOKING WEST ON US 191 AT
INTERSECTION WITH GOOCH HILL



LOOKING SOUTH ON GOOCH HILL
AT INTERSECTION WITH US 191



LOOKING NORTH ON GOOCH HILL
AT INTERSECTION WITH US 191



ON FRONTAGE ROAD LOOKING SOUTHEAST



ON FRONTAGE ROAD LOOKING SOUTHWEST



ON BOZEMAN TRAIL LOOKING NORTHWEST



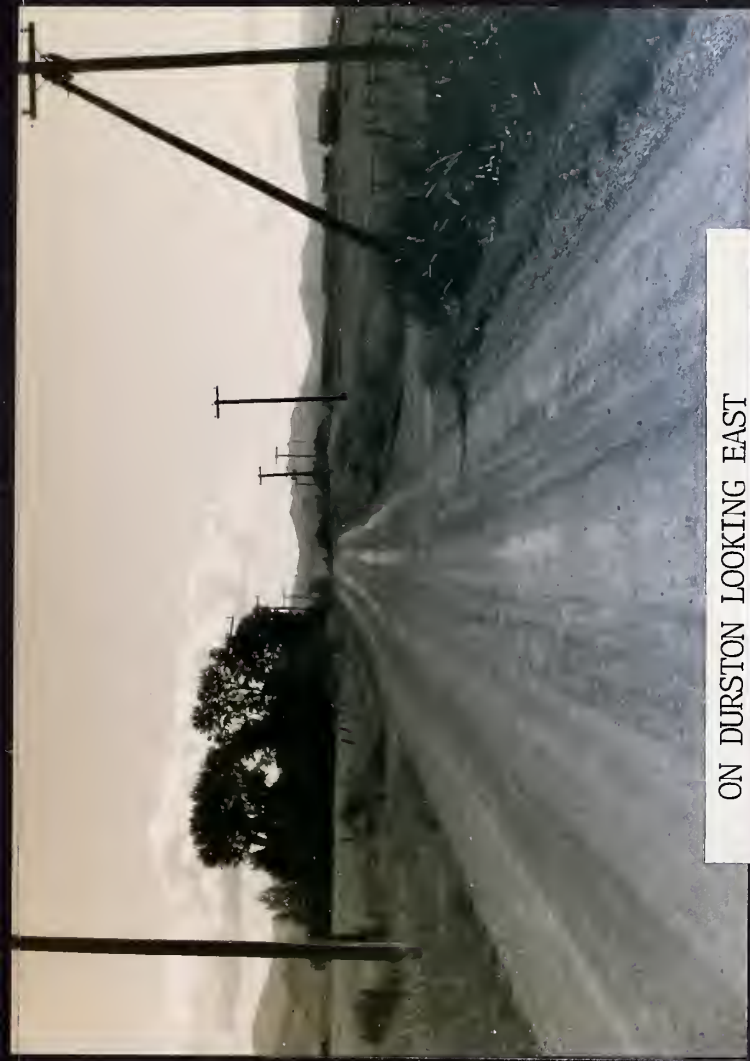
ON-OFF RAMP & BOZEMAN TRAIL
CENTERLINE INTERSECTION
LOOKING NORTHEAST



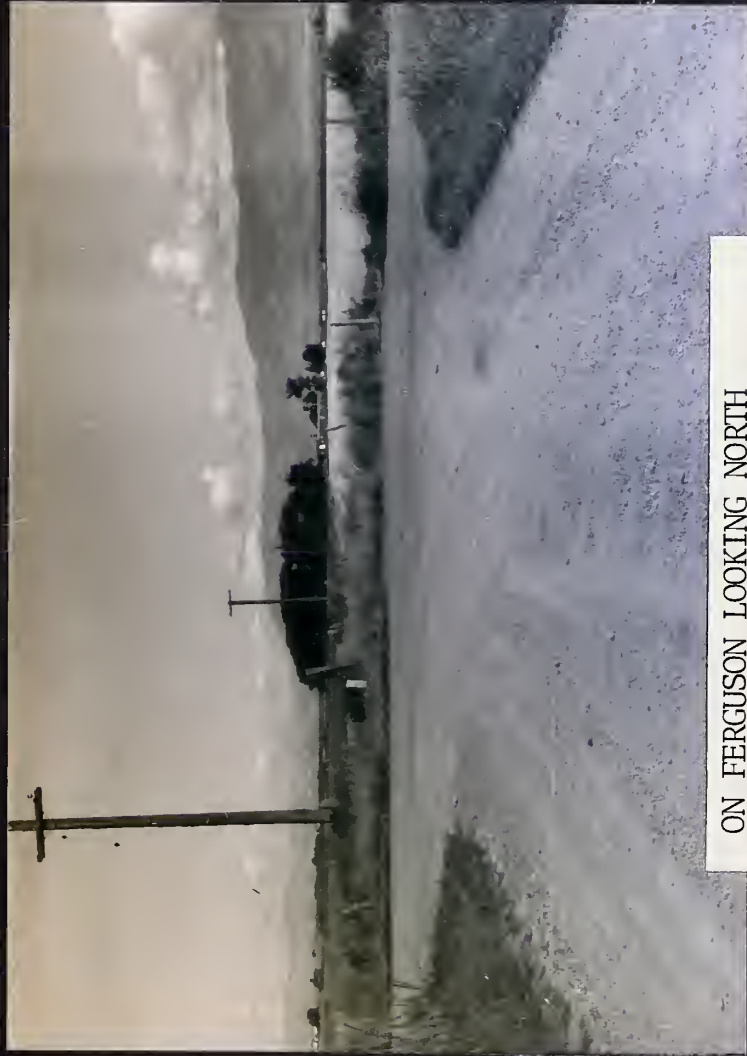
UNDER INTERSTATE 90 LOOKING EAST



ON DURSTON LOOKING WEST



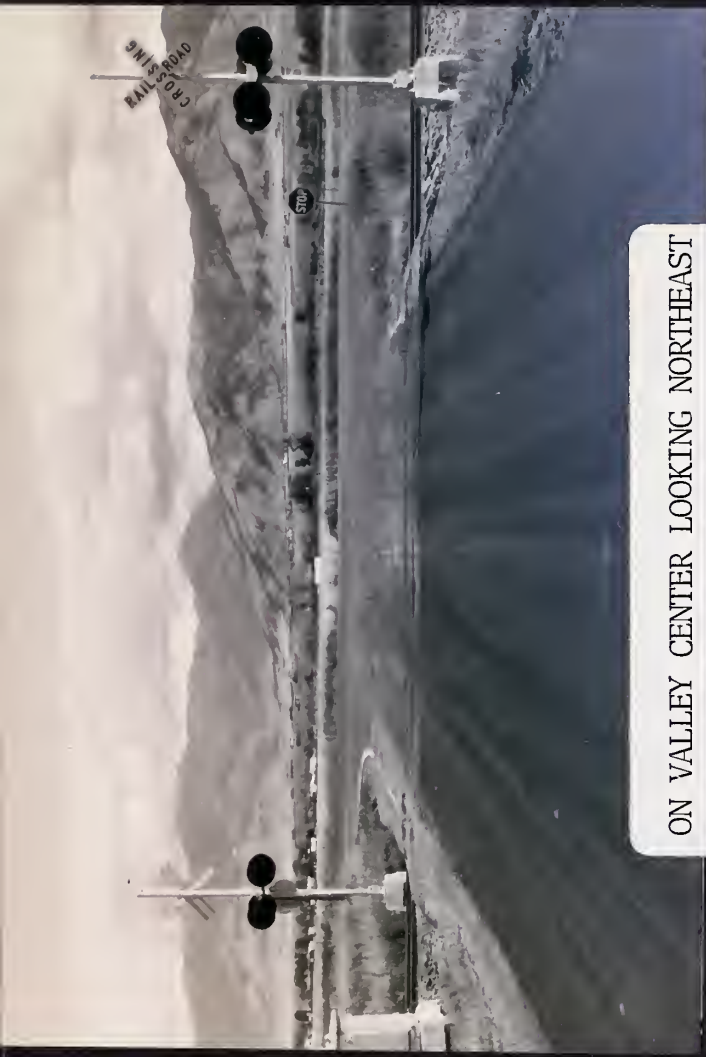
ON DURSTON LOOKING EAST



ON FERGUSON LOOKING NORTH



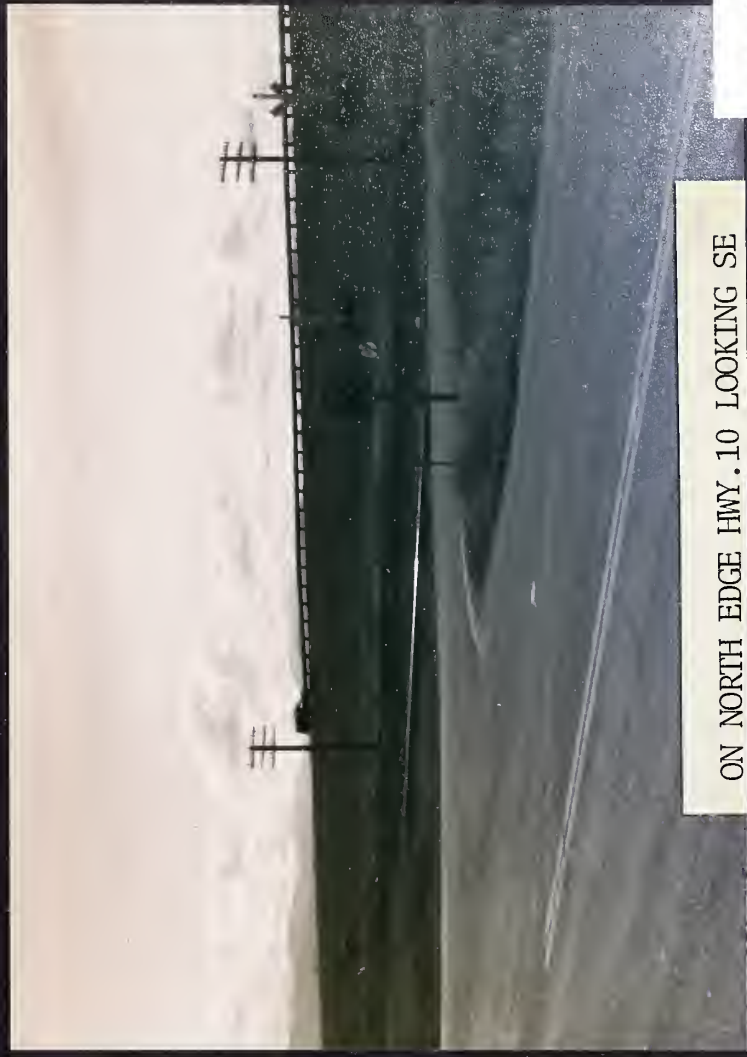
ON VALLEY CENTER LOOKING NORTHEAST



ON VALLEY CENTER LOOKING NORTHEAST



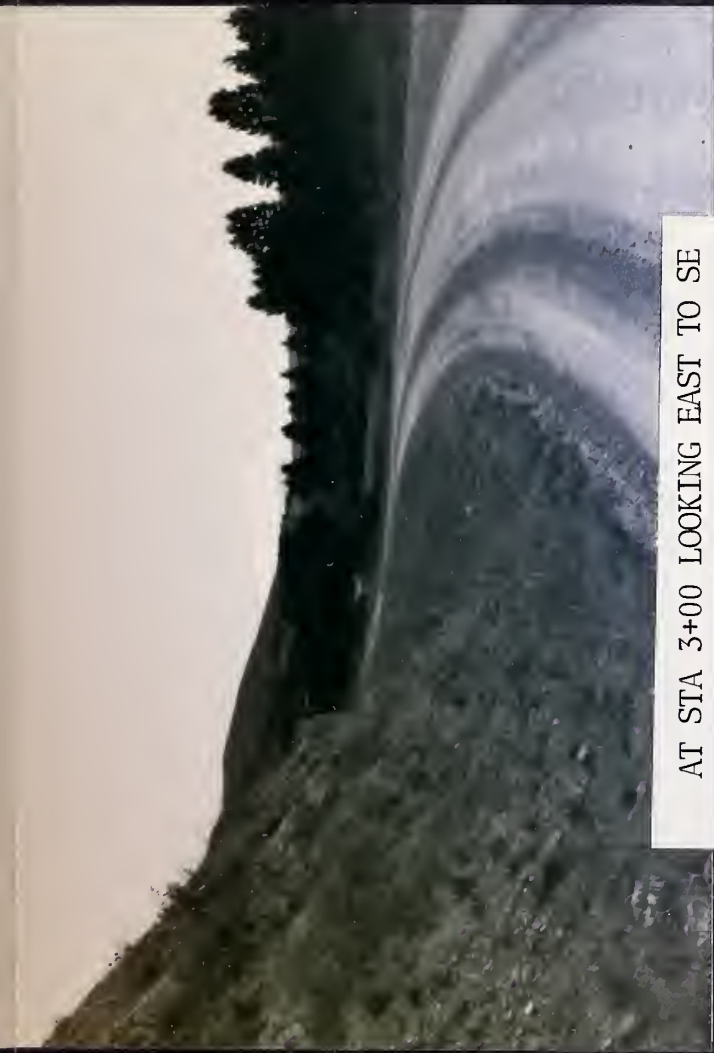
ON NORTH EDGE HWY. 10 LOOKING SW



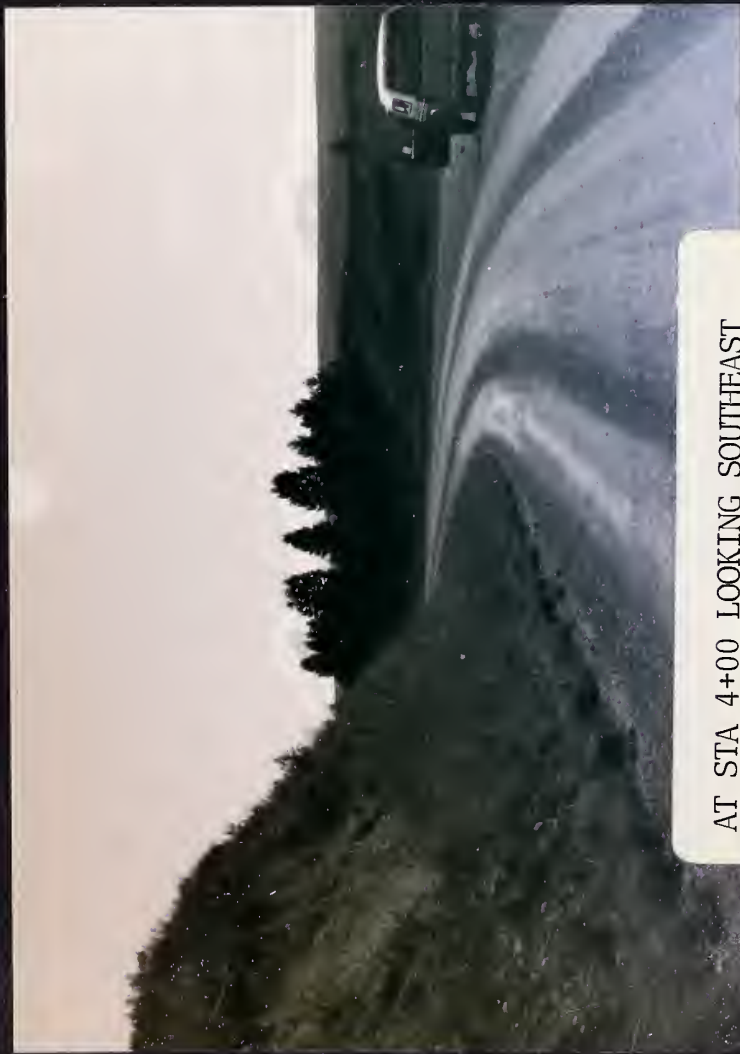
ON NORTH EDGE HWY. 10 LOOKING SE



AT STA 1+00 LOOKING NORTHWEST



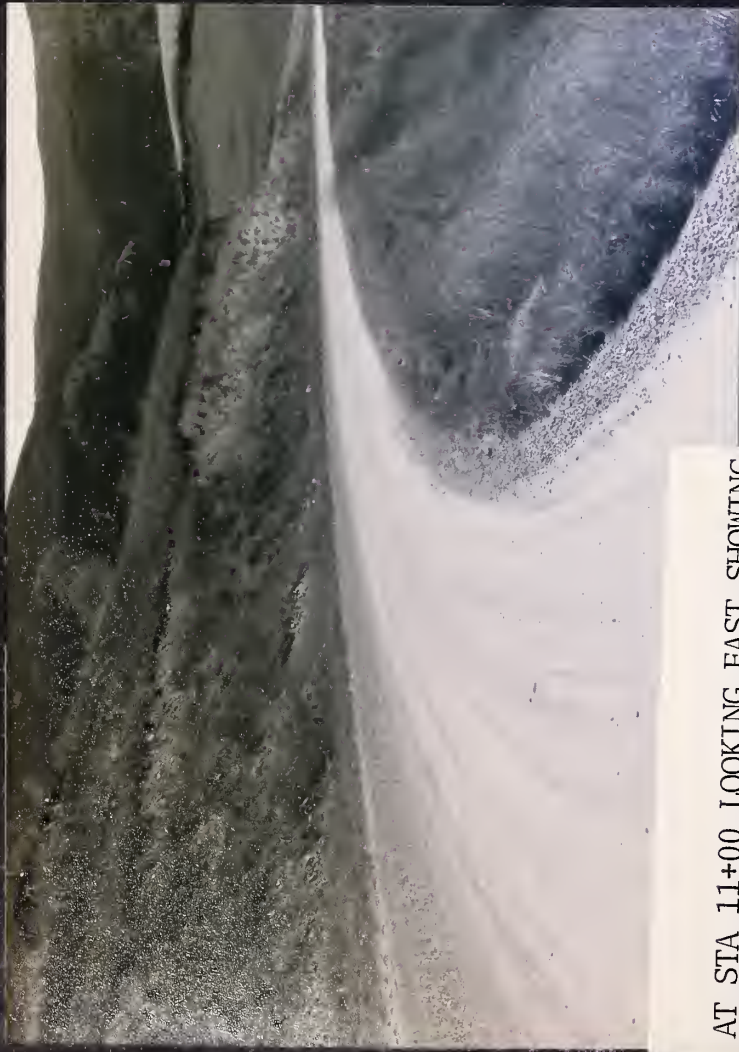
AT STA 3+00 LOOKING EAST TO SE



AT STA 4+00 LOOKING SOUTHEAST



AT STA 9+00 LOOKING NW SHOWING
SUPERELEVATION ON INSIDE



AT STA 11+00 LOOKING EAST SHOWING
SUPERELEVATION & STEEPNESS OF
ROAD EDGE



AT STA 18+00 LOOKING WEST SHOWING
STEEP BANK ON RIGHT SIDE OF ROAD



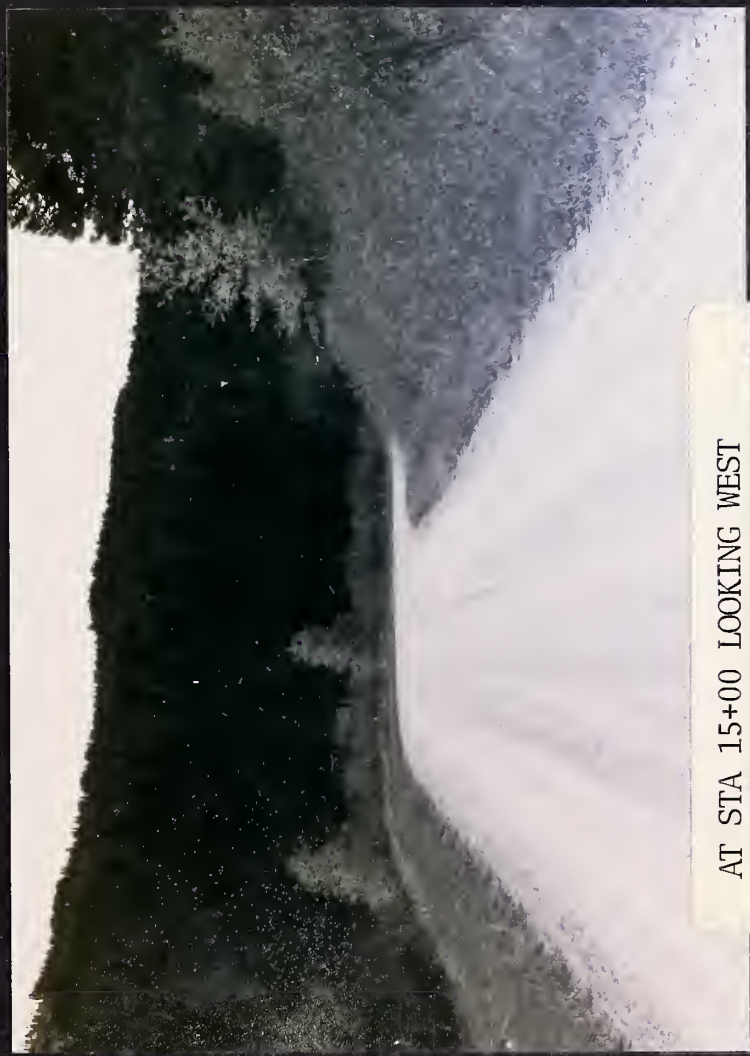
AT STA 22+00 LOOKING EAST



AT STA 4+00 LOOKING SOUTHEAST



AT STA 13+00 LOOKING NORTHWEST



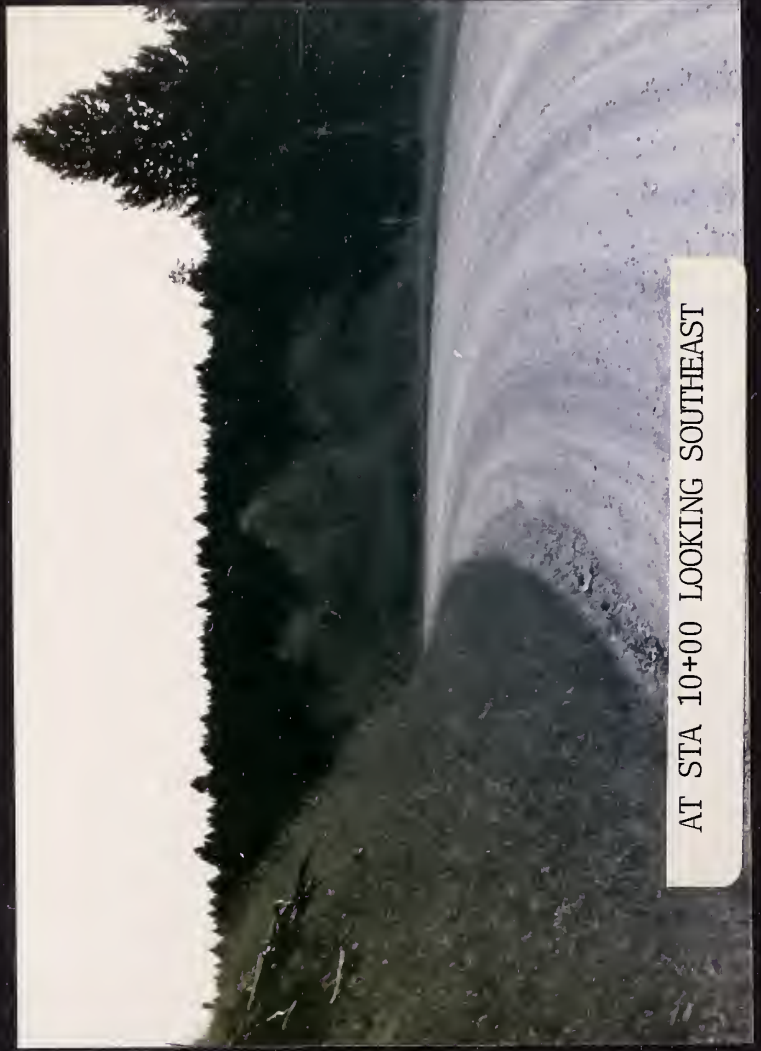
AT STA 15+00 LOOKING WEST



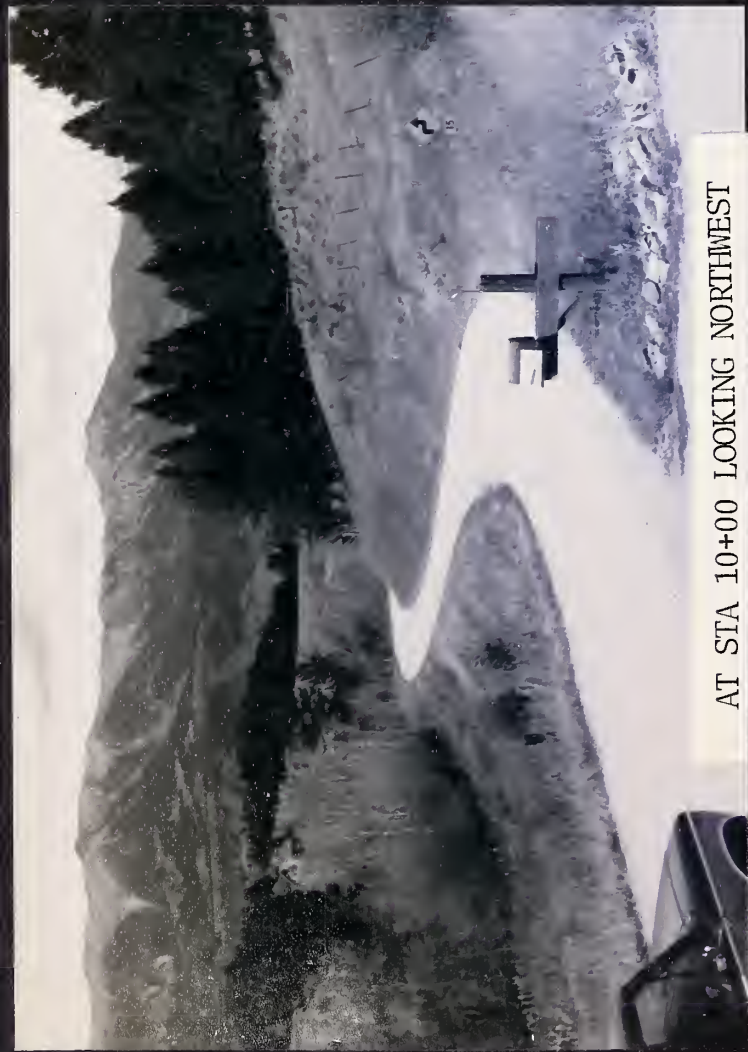
AT STA 5+50 LOOKING SOUTHEAST



AT STA 5+50 LOOKING NORTHWEST



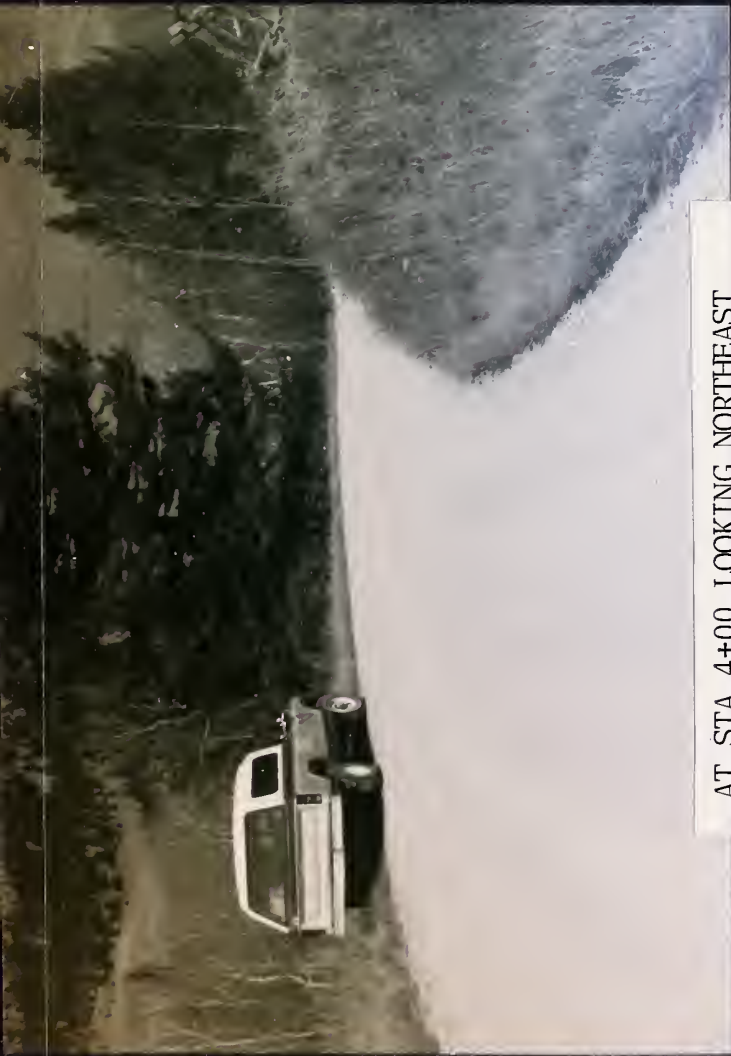
AT STA 10+00 LOOKING SOUTHEAST



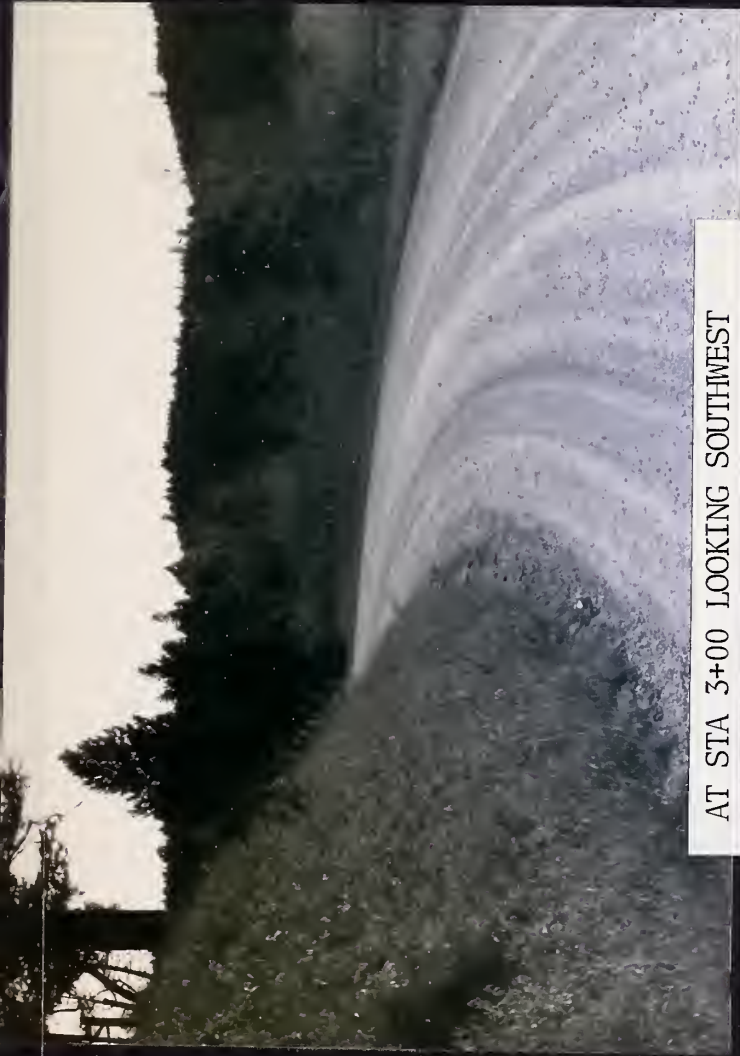
AT STA 10+00 LOOKING NORTHWEST



AT STA 5+00 LOOKING NORTHEAST



AT STA 4+00 LOOKING NORTHEAST



AT STA 3+00 LOOKING SOUTHWEST



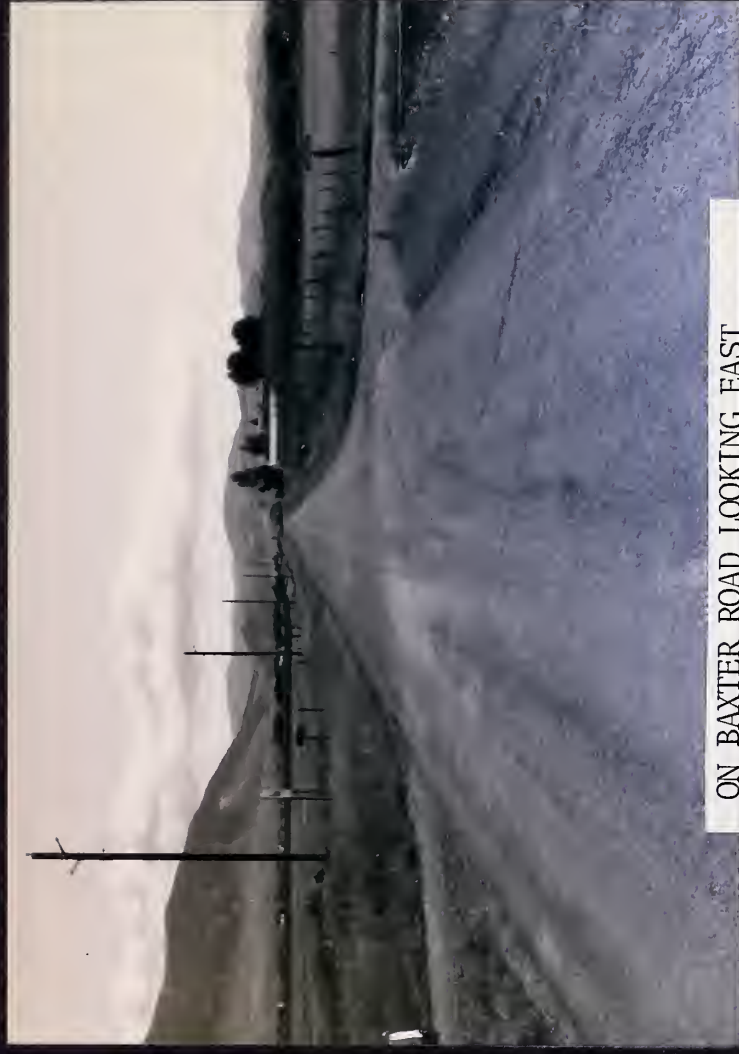
AT STA 1+00 LOOKING WEST



AT STA 2+50 LOOKING SOUTHWEST



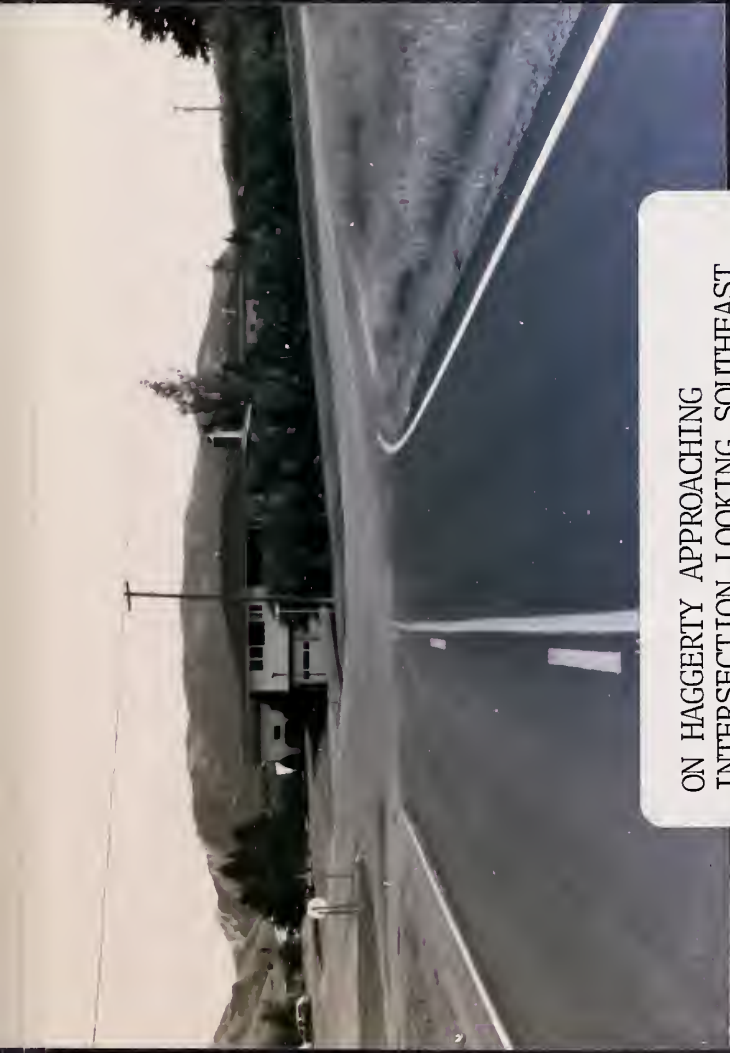
ON FLANDERS MILL LOOKING ONTO
BAXTER RD.



ON BAXTER ROAD LOOKING EAST



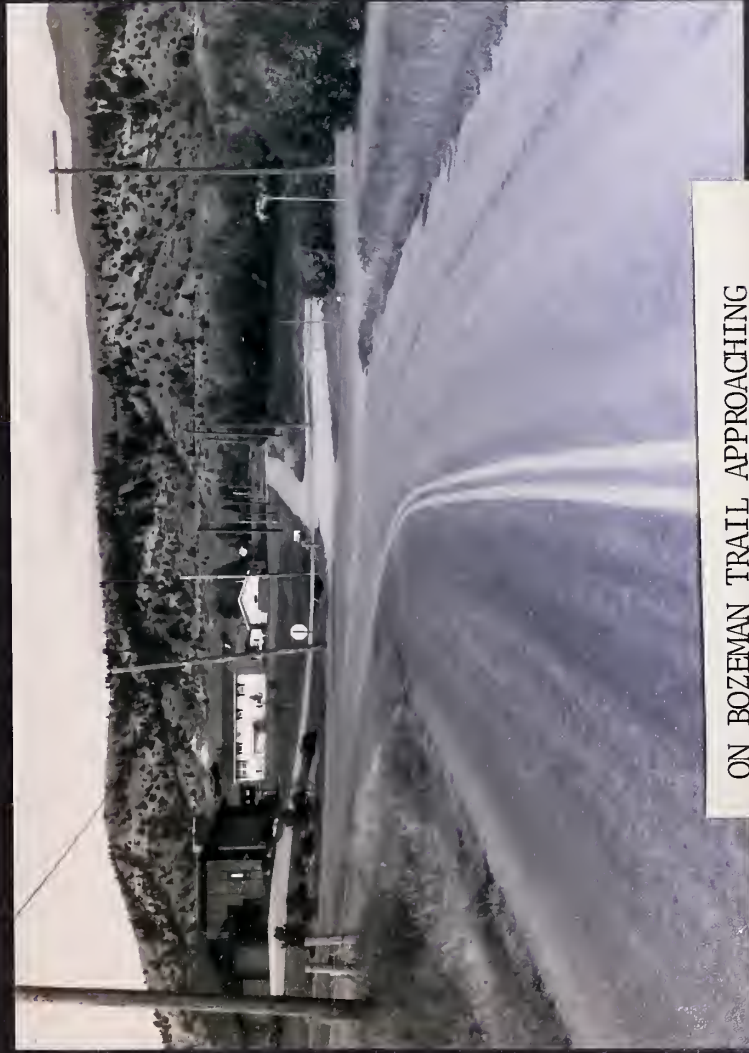
ON BAXTER ROAD LOOKING WEST



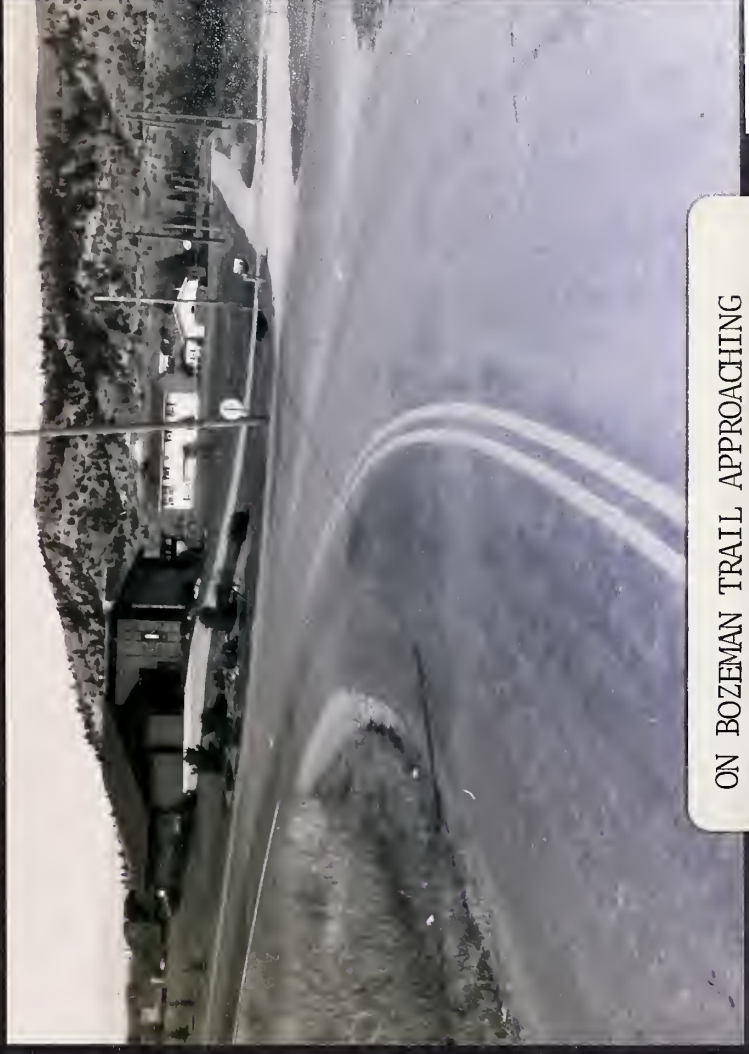
ON HAGGERTY APPROACHING
INTERSECTION LOOKING SOUTHEAST



ON HAGGERTY LOOKING SOUTHEAST
SUPERELEVATION ON CURVE



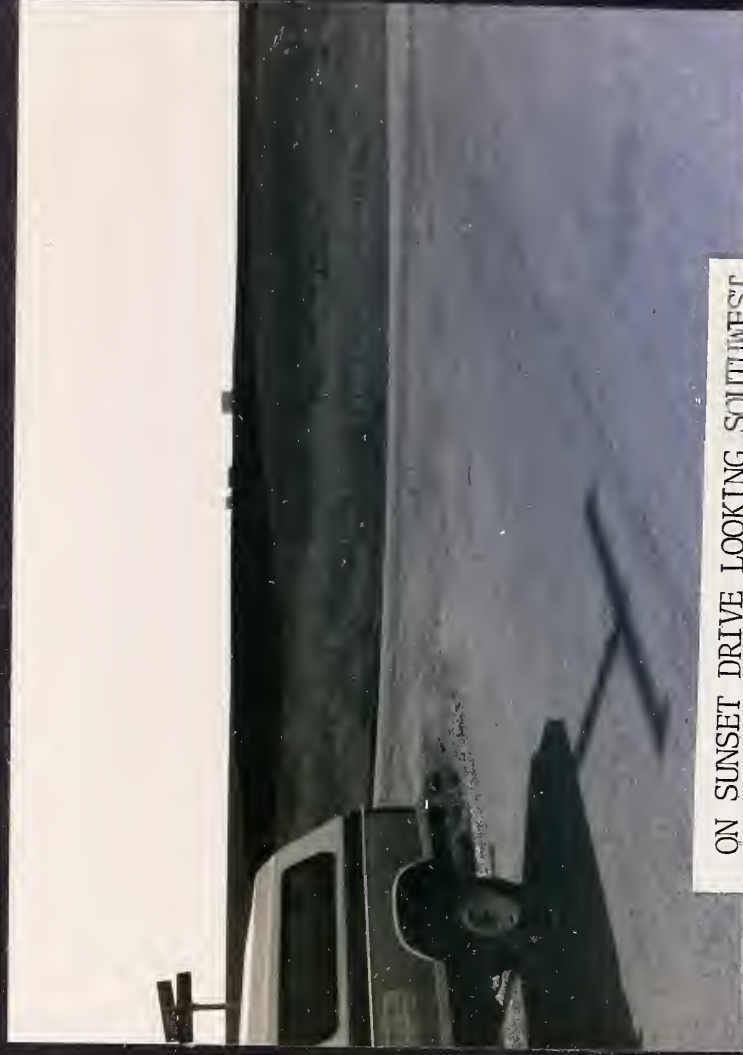
ON BOZEMAN TRAIL APPROACHING
INTERSECTION



ON BOZEMAN TRAIL APPROACHING
CURVE ONTO HAGGERTY LANE



ON BOZEMAN TRAIL LOOKING SOUTH



ON SUNSET DRIVE LOOKING SOUTHWEST

